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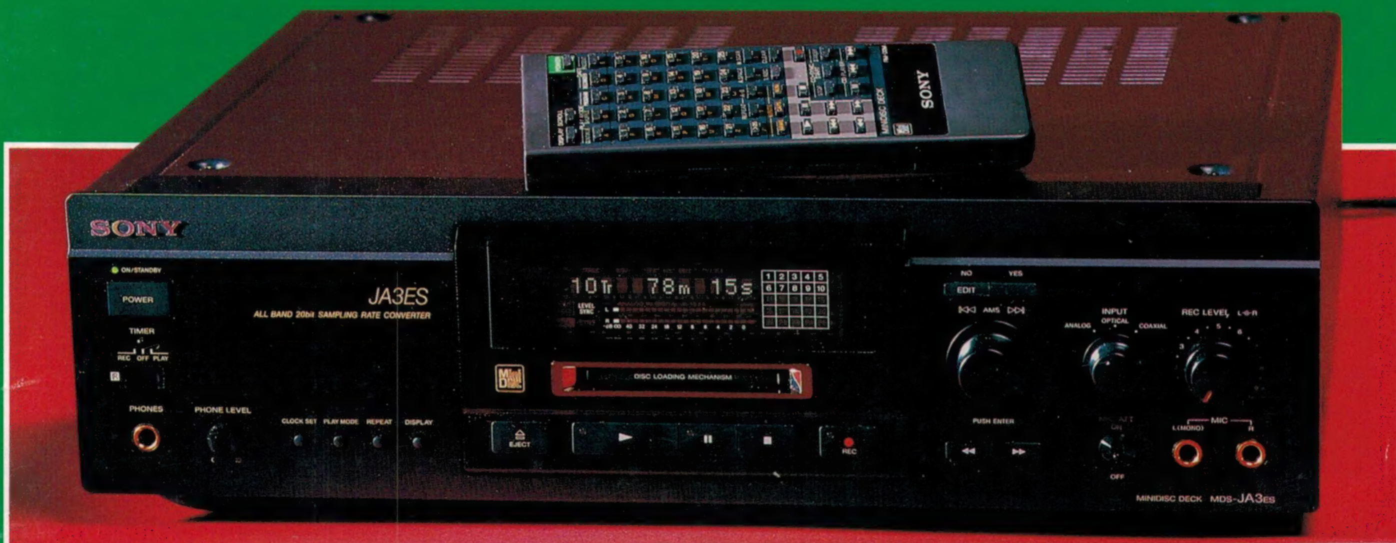

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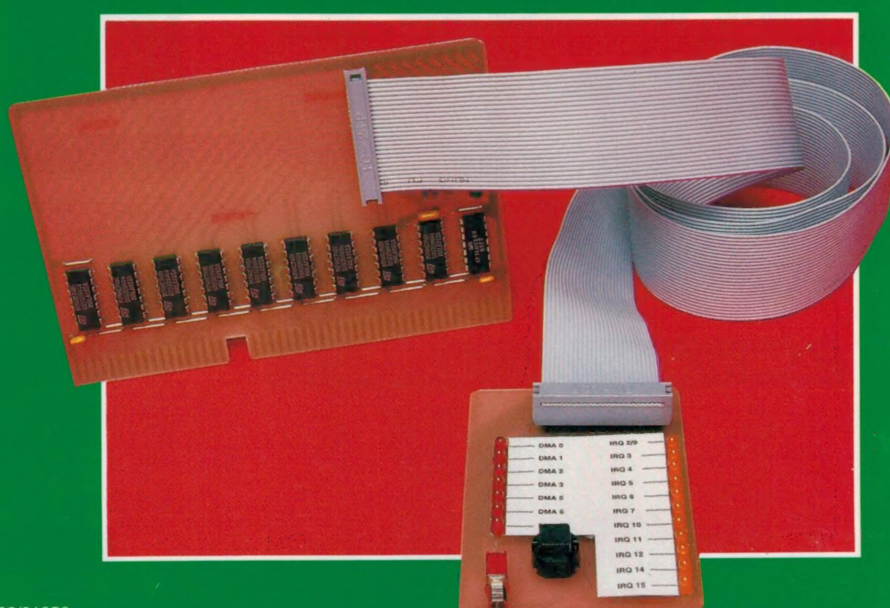

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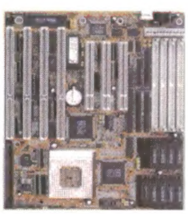

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s - built-in stereo speakers
d - digital control

Volume 58, No.10
October 1996

Electronics

AUSTRALIA with Professional Electronics & ETI

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

But what of the *quality*?

There's been a lot of media coverage about the range of programming on the new Pay TV networks, but very little indeed on the actual image and sound quality they're delivering. We asked Barrie Smith to see what he could find out, and the results make interesting reading. See page 22.

40MS/s Logic Analyser

If you need a logic analyser for troubleshooting in digital circuits, commercial models carry price tags starting in the thousands of dollars and rising rapidly — especially if you want 32 input channels and sampling at up to 40MHz. But you can now build one yourself, for only a couple of hundred dollars. See page 90...

On the cover

Sony's new JA3ES MiniDisc Recording Deck features the latest ATRAC technology. Reviewer Louis Challis found its performance so good that he's rated it the best piece of domestic audio gear he's ever tested. (See page 10). Also shown is our exciting new PC Bus Sleuth project. (Photos by Phil Aynsley, Ben Duncan.)

Video and Audio

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Projects and Technical

Columns and Comments

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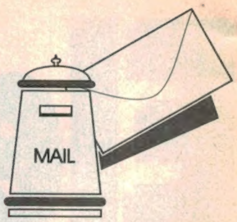
ELECTRONICS AUSTRALIA is published by Federal Publishing Company, a division of Eastern Suburbs Newspapers Partnership, which is owned by
General Newspapers Pty Ltd.
A.C.N.000 117 322,
Double Bay Newspapers Pty Ltd.
A.C.N.000 237 598, and
Brehmer Fairfax Pty Ltd.
A.C.N.008 629 767,
180 Bourke Road, Alexandria, NSW 2015.

Printed by Macquarie Print, 51 - 59 Wheelers Lane, Dubbo 2830. Phone (068) 843 444.
Distributed by Newsagents Direct Distribution Pty Ltd, 150 Bourke Rd, Alexandria 2015; phone (02) 9353 9911.
ISSN 1036-0212

*Recommended and maximum Australian retail price.

LETTERS TO THE EDITOR



Speakers vs 'live sound'

I do wish people induding Peter Phillips, (Information Centre, April 1996) would stop perpetuating the myth that it is only pop music and movie music that needs a high sound level. It is true that pop music has few quiet bits, and movie sound tracks have lots of bangs and thumps, but live orchestral music — at least at the ABC concerts I go to, and from the seats I sit in — contains noisy bits much much louder than most speakers can reproduce accurately.

I really really hope the ABC is never conned into trying to augment the sound of its orchestras. I have been to some pre-concert talks where samples are played over the theatre's sound system. I am sure that the sound system was doing its best. It was very good in the sense that a photograph of a beautiful landscape can be beautiful — but it is not the landscape. Instead of spending megabucks on electronics, including speakers, I would much prefer that they hire a few more musicians, and allow more time for practice.

I can easily believe Peter didn't find speakers capable of doing justice to Mahler's second. The *Resurrection* is meant to portray — well, the whole of heaven opening up and the salvation of all humanity. Really good speakers deliver a very impressive performance, and it is easy to imagine a piece of heaven opening up and quite a few people attaining salvation. But only a real orchestra in a real concert hall can have the whole audience — including those who aren't Christians — feeling that they too, have been saved.

Keith Anderson
Kingston, Tas.

Fuse query

I have today received my copy of the July 1996 issue of *Electronics Australia*. It is with some interest and amusement that I noticed your closeup picture on the front cover of the printed wiring board of the new 50 watt per channel amplifier seems to show a blown fuse with a piece of wire soldered across it.

Looking at the wiring layout of the PWB it seems that the fuses are in series with each side of the power transformer secondary winding. After many years in the service industry it has been my experience that this practice leads to 'fuse fatigue' after a number of 'turn ons', due to the extreme current drawn by the filter capacitors at turn on. A more reliable solution to protection of the device is to fuse each channel's DC power supplies after the capacitors and rely on a suitably rated mains fuse for protection of the transformer, rectifier, filter capacitors, mains switch etc.

This amplifier will probably be built by the younger members of the electronics community, due to the simplicity of the design. Experienced audio people will realise that hybrid output devices are not really capable of producing the highest quality sound.

Let us show project builders the most reliable way to construct a power supply. If one fuse blows due to a fault condition in one output IC, there is a chance of 1/2 Vcc being delivered to the other IC, especially if a home made fuse is used which may have a much higher rating than the proper replacement.

Without looking at the 'shut down' characteristics of the LM3886 and without a relay protector in the speaker leads of this design, is there a possibility of 1/2 Vcc appearing at the speaker terminals, with dire consequences for the speakers connected? With separate DC fuses this can not happen to the 'good' channel and the extra cost involved is minor.

Brad Sheargold
Collaroy, NSW.

Still with us

I had all intentions of not continuing with *EA*, and did cancel my subscription. This was a very traumatic experience after all the years I had been a reader, but then you published the dual battery controller in the Januury issue. This was an item that I was interested in, and so I bought the magazine. It was only a couple of weeks later that the subscription department called up to see if I would consider keeping up my subscription, and I decided that I am too old to put up with the withdrawal symptoms of not having my monthly fix. So I am again back in the fold.

Actually there's another reason for

writing again. On the morning of Saturday May 4th, I received a phone call from a Brian Baker in New Zealand who just that morning had received his edition of *EA* and had read the letter of mine that was published. He was ringing to express his sorrow that I had cancelled my sub, but as it turned out I had had a change of mind and this pleased him very much.

He is about my age and spends a lot of his retirement collecting old valve radios and test equipment and giving them a second lease of life. He has a lot of the original manuals for them and he is also interested in obtaining old issues of *Radio & Hobbies* from the 1940s and 1950s for his collection.

Hopefully you might like to give him a plug (or maybe he could be of help to other restorers). His address is Brian Baker, Wellington Street, Russell, New Zealand 0255; phone 094 037 718. I am sure he would like to hear from local enthusiasts.

Cliff Barron
Kingsholme, Qld.

ESR Meter Project

I've just finished building the ESR & Low ohms Meter project that was in your magazine in January 96.

Over the years I've built a number of kits and have always been amused at the amount of space that is wasted and the amount of components that are used for such little purpose.

But not so with this little beauty. Designer Bob Parker should take full marks for such a well designed and also functional kit. Resistors, transistors and ICs all placed really tightly together, and everything simplified with the help of the Z86 CPU.

My only criticism is there is not ANY info on the Z86E0408 — like how it works? What instruction code was used? How do we (the kit builder) program these micro's?

I personally would like to see more of these types of kits, but also with a BYTE more info on the micro's and programming. That would also mean more people would be able to design projects for publication, and for our own use.

Allan Simpson,
Via the BBS. ❖

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of Electronics Australia. We welcome contributions to this column, but reserve the right to edit letters which are very long or potentially defamatory.

EDITORIAL VIEWPOINT

Reflections on galloping Test & Measurement technology...

In the past, electronics people have tended to think of their test instruments as being in a different category from the rest of the equipment they dealt with. Your instruments were rather like the tools of a skilled cabinet maker or other traditional craftsperson — if you bought the best quality you could afford, and carefully looked after them, they'd probably last you for almost your entire career...

But it's been clear for some years now that electronic test instruments are in reality no more immune to the effects of galloping technology than anything else. Just like computers, their effective working life is steadily shrinking (although for different reasons). And this is a particularly apt analogy, it seems to me, because although many test instruments may still look like their predecessors, inside they've changed. In many cases they're now a dedicated microcomputer, with special-purpose interfaces for the user and 'external world'.

The full impact of these developments really hit me a few weeks ago, when (along with other editors) I attended a press function held by Tektronix to preview its exciting new TDS 200 Series of compact digital oscilloscopes — see our news story on page 106. I think we were all rather taken aback by the leap forward that Tek has taken with these new instruments, in terms of both performance and price.

There's little doubt that these new scopes are going to cause a major shakeup at the lower end of the scope market, until now dominated by traditional analog models. But what struck some of us as well was the fact that the price for a given level of scope performance had suddenly dropped by about 50% — and conversely that the performance available for a given cost had roughly doubled. Great news for those just about to buy a new scope, for example, but a bit sobering for those of us who had recently bought one!

Oh well, just because a camera may be obsolete doesn't mean it won't still take some good pictures, does it? As long as you can still buy the film for it, of course...

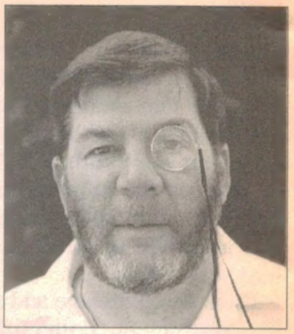
On a different note, starting with this issue you'll find there's now a big added incentive for you to send in your circuit ideas and innovations, for our Circuit and Design Ideas column. Thanks to Allthings Sales & Services, of Westminster in WA, we're now able to award a special prize each month for the contribution we judge most innovative. The prize is an exciting new CCD video camera module, measuring only 32 x 32 x 27mm and offering 460 TV lines of resolution, with a sensitivity of only 0.08 lux. Valued at $199, it has many interesting applications and is ideal for experimenters. Our first winner is announced on page 50 — but why not see if *you* can win one, too?

Jim Rowe

Footnote: You'll find that our regular 'When I Think Back' column is missing from this issue, as Neville Williams has been unwell. He is now on the mend, though, and we're hoping that his column will re-appear next month.

Moffat's Madhouse...

by TOM MOFFAT



Computer 'monkey business'

Computer viruses — all a bunch of hype, right? A dastardly plot by people who manufacture virus scanners, to scare the hell out of innocent computer users, right? Even I, writing with my usual infinite wisdom, have insinuated in the past that the 'virus scare' is just that, and no more. It could never happen to you. Or me. Wrong!

Yes, my friends, I copped a virus good and proper. Not in just one, but two computers. And I got the virus in the classic way — the way I'd been warned of many times, but I'd always just pooh-pooh'ed it...

Perhaps if I tell the full story of this sorry business, you readers out there might avoid a similar fate.

It all started after I landed a job with the biggest Internet Service Provider on the Olympic Peninsula, on the northwest tip of the USA. This was a three-part job: working the technical support telephone line for Olympus.Net, re-writing most of its on-line and mailed-out documentation, and system administration duties.

The support and documentation roles meant I had to have access to a computer capable of running Windows 95, and my trusty Toshiba laptop from three years ago just didn't have the memory or muscle to cut it. So there was my excuse to buy a nice new Pentium laptop, with colour screen, and the company would finance my purchase with an interest-free loan paid back out of wages.

Off I went to the mega-computer-video-hifi-electronics store at Silverdale, about 40 minutes from home in Port Townsend but near enough to Seattle to feel the price competition. I was targeting the lastest model Toshiba notebook computer. And there they were, all lined up on a display counter, chained down so nobody could pinch them, but still available to test out (play with).

I fiddled with the Toshiba for a while, but further down the counter was a sleek dark laptop with a prettier screen and keys that actually moved like a typewriter's when you pressed them. Further investigation revealed that this machine — a Texas Instruments Travelmate 5000 — had a sound card and a hopped-up graphics system that would do multimedia stuff, something the entry-level Toshiba was lacking. This TI machine had originally been priced at US$3900, nearly double the price of the Toshiba. But this was an 'end-of-model runout', so the store had knocked them down to $2500.

I decided this whole business needed some serious thinking about, so I left the store empty-handed. I also wanted to study some magazine reviews, to see what *they* thought of the Travelmate. It looked pretty good (computer of the year in one case), so off I went again, Visa card in hand, to collect my new Travelmate. But — when I got to Silverdale, they were all sold out. Except, that is, for one lonely machine, the one that had been on display.

"You can have this one", they said. "It's good as new, and we'll knock a further five percent off the price." Well, I didn't really have much choice. It was that machine or nothing, so I paid my money, collected my new computer, and went.

It soon became obvious that this computer was no bargain. When I got it home I noticed the hard disk was making funny squealing noises. The floppy drive frequently threw up read errors, and the PCMCIA slot wouldn't work at all with the memory card I wanted to use.

This was a real concern, because my old Toshiba had a 'hard RAM' — a non-volatile RAM disk that I used as my working disk for all my projects. The Travelmate wasn't so equipped, but I had intended to use a one megabyte plug-in card as my working disk. But the computer absolutely refused to recognize it. Phooey!

A bit of poking around in Windows 95 revealed a system performance report, and this one claimed the performance was degraded because Windows was running in 'DOS Compatibility Mode'. This in turn was brought about because the computer detected a change in the hard disk boot sector, 'possibly as a result of a virus'. That was my cue to copy the virus scanner out of my old Toshiba and give it a good run in the Travelmate. Result: no virus detected.

Another concern was the game of 'Doom' that I found installed in the computer. Surely the computer didn't *come* with Doom, and I doubted they would let some kid with a disk come in and install Doom. Would they? Then I got to thinking — maybe this computer wasn't so new; maybe it had gone home with somebody and been returned for some reason. Had it been roughly treated, even dropped? The retailer had a 30 day money-back satisfaction guarantee; what happened to the computers that came back? Did I have one?

A couple of days later the hard drive noises were worse, as were the failures in the floppy drive. So the good people at Texas Instruments called the computer back to the factory for urgent repairs. They said the hard drive was going to be either re-formatted or replaced, so I should save any valuable data. This I did, via many tries on the shaky floppy drive.

Sure enough, the computer came back with a nice new hard drive installed, but the service people had been unable to find anything wrong with the floppy drive. Just for fun I checked the performance test again, and this time it reported Windows 95 was running at full performance, with no mention of boot sector changes or virus suspicions. Then the floppy drive died altogether, so the computer went off for service again, for the second time in a week.

A couple of days later the Travelmate was back home again with a new floppy drive, as well as a new keyboard. At least with the disk drive working I could reload some of that software I'd saved from the old hard drive. But I only got as far as loading some sound card drivers when the computer locked up com-

pletely; the only way to turn it off was to remove the battery.

Now the hard drive was playing up again, with suspected controller problems, and the machine had again reverted to 'DOS Compatibility Mode', along with dire warnings about viruses. As well, the latch on the computer's lid was starting to go...

I want a new one!

With that, I rang the place I'd bought the computer and told them I wanted either a new one, or my money back. And although it was a superseded model, they did manage to find a brand new computer at another of their store branches. It would be mine in a week.

While waiting for the new machine I continued to use the faulty one, doing simple word processing jobs and learning to use Windows 95. It was a worrying business, and I soon decided it might be a good idea to transfer copies of the word processing files to my Toshiba laptop in case the faulty computer packed it in altogether.

So I loaded all the important stuff onto a 3-1/2" disk, and then copied the disk to the Toshiba. I sent a couple of text files onto the RAM 'working' disk and then checked them once more with the Toshiba's word processor. And at that stage the Toshiba's RAM disk died!

That wasn't totally unexpected; it had died before when I crashed the computer, and also when I let the battery run down too far. On past experience, all I had to do was reformat the RAM disk and it would be fine again. But this time it refused to format, claiming it was 'unable to write boot sector'. Boot sector? Hey! Boot sector on the Travelmate, boot sector on the Toshiba...

That got my virus suspicions up again, but this time I got onto the Internet and downloaded the very latest version of the McAffee anti-virus software. Once it was safely in the Travelmate I turned it loose for a search, and back it came — 'Found traces of the Monkey-B virus'.

On the same Web site I remembered seeing a special program specifically aimed at the Monkey-B virus, a thing called Killmonk. So I went back and downloaded Killmonk. It came as a ZIPped archive file, containing the main program and a text file with a very detailed description of how the Monkey-B virus works.

It seems that the Monkey-B virus originated in western Canada, not far from where I live in the northwest of the USA. So maybe Monkey-B is fairly local. Then again, it could be thriving in Australia, but on the surface that doesn't seem very likely. According to the document with the Killmonk program, the virus can only travel by physical transmission between computers; in other words, not over the Internet.

Boot sector virus

Monkey-B is an infection that resides in the boot sectors of floppy disks (every floppy has a boot sector assigned, even if it is not a bootable disk). As soon as any read is made from an infected floppy, the requested data is transferred normally. But at the same time, the virus is copied from the boot sector of the floppy to the boot sector of the hard disk. Then, when the infected computer writes to another floppy disk, the Monkey-B virus goes right along with it, from boot sector to boot sector.

The effect of Monkey-B is interesting. It does nothing at all to the main hard disk on a computer, and if you've got only one hard disk, you'd never know the virus is there. It instead infects the SECOND hard disk, screwing up its boot sector. In my case BOTH computers have second hard disks, in the form of RAM disks. That explains why the plug-in memory card on the Travelmate refused to work, and it explains why the built-in permanent RAM disk on the Toshiba dropped its bundle.

So how did my virus infection take place? I suspect it first entered my life via a kid carrying a disk with the Doom game on it. He loads Doom into the first Travelmate, and at the same time the virus transfers from the boot sector of his floppy to the boot sector of the Travelmate's hard disk.

I bring the first Travelmate home. It starts playing up, it's called back in for service, so I transfer the important stuff onto several floppy disks for safe keeping. The virus copies onto the boot sector of each of the floppies.

The repaired Travelmate comes back, I start loading files onto it from the backup floppies. The virus copies from the floppies onto the boot sector of the Travelmate. More hard disk problems begin developing.

With a suspect hard disk, I copy my most important files onto a fresh floppy, and the virus copies to its boot sector. I transfer the floppy to my Toshiba, and then copy the disk files across to the Toshiba's hard drive. The virus goes with them. I then try to log onto the Toshiba's permanent RAM disk and the disk promptly crashes.

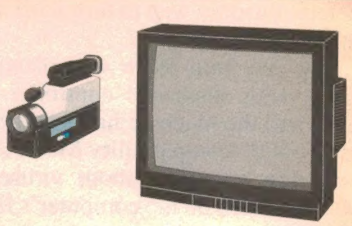
The good news is that the Killmonk virus zapper worked like a champ. It quickly restored the Travelmate so that the PCMCIA memory card worked properly, and Windows 95 no longer complained about MS-DOS compatibility mode. Running Killmonk in the Toshiba brought the RAM disk back to life. And that left the job of disinfecting all those floppies. Killmonk scrubbed them one by one, but did I get them all? Only time will tell.

I hopefully got rid of all traces of the virus on any disks, well before the replacement Travelmate arrived. This new computer has worked perfectly since day one, and after a month of use it's shaping up as the best computer I've ever owned. The effects of the Monkey-B virus appear temporary and reversible, but I'd still rather stay right clear of it, thanks very much!

It'll never happen to me? Well, *I* learned *my* lesson. And what a mess to clean up! I'm not yet paranoid enough to use one of those scanners that goes over the hard disk every time you turn on the computer. But I shall certainly think twice about plugging in any floppies of unknown parentage. And I guess I'll be a little more careful of stuff downloaded from the Internet — although to this day I've never encountered any virus problem from that source — yet.

Is Australia safe from Monkey-B? Well, consider a businessman flying back from the USA — did his laptop computer get infected there? Now he's headed for Sydney, and when he gets back to his office he's going to hand around copies of the latest spreadsheet he's been working on. Here, take this disk... v

What's New in VIDEO and AUDIO



Home Theatre packages from Panasonic

To meet the growing demand for home theatre systems, Panasonic has announced a range of home theatre packages which combine Panasonic and Technics products. By combining a Panasonic television, a 'Hi-Fi' VCR and a Technics Dolby Pro Logic system including speakers, customers are able to buy packages ranging in price from $3500 to $14,000.

The packages include conventional television receivers ranging in screen size from 51cm to 68cm and widescreen models of either 66cm or 76cm, right up to the 119cm TX-47WG25H Wide Screen Video Projection System. VCR options are either the NV-HD600 or for the top end range the NV-HD650. There are also two Dolby Pro Logic mini systems to choose from, the SC-CH770 and the SC-CA10 for the top end range.

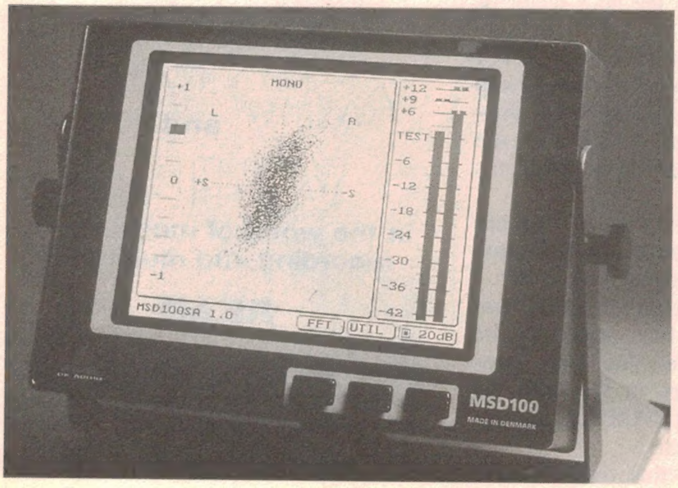
Panasonic has also developed four purpose-built furniture units to house the package options, completing the Home Theatre Concept.

The Technics SC-CH770 and SC-CA10 mini hi-fi systems are both new models which include Dolby Pro Logic with centre and rear speakers as standard, as well as the front left and right speakers. They deliver 25W RMS x 2 for the surround channels on both systems. There are three Dolby Surround modes: normal, wideband or phantom.

The Panasonic Hi-Fi Video Cassette Recorders included in the packages are both existing models and include Panasonic's four-key easy programming and television compatible remote control.

Low cost Master Stereo Display system

The new DK-Audio MSD 100 Master Stereo Display is a self-contained compact audio display system ideal for broadcast audio monitoring, live and studio recording, post production and hard disk recording. Incorporating many of the features of DK-Audio's existing MSD550, the new MSD 100 family delivers claimed 'see what you hear' monitoring in an affordable package.



The MSD 100 is a combined phasemeter, audio vector oscilloscope and level meter, developed by DK-Audio of Denmark to provide immediate and accurate information of any stereo signal. By visualising stereo signals, the Master Stereo Display makes signal characteristics immediately obvious to the eye that are difficult to discern with the ears alone.

The system uses a super-fast, high resolution LCD screen with CCFT-backlight operating under DSP control to simultaneously display the phase correlation, M-S audio vectors and program level of any analog stereo signal. The level meter features six international PPM and VU scales with digital peak detection and flying peak segment, peak hold and fast peak hold functions. Dedicated bright red LED indicators above each of the level meter scales display signal overload.

In addition to the basic MSD 100 model, the MSD 100AES also includes digital signal inputs on XLR connectors for direct display of AES/EBU digital audio signals. FFT spectrum analysis functions are available for both analogue and digital models. Also available is the MSD 150C, equipped with a multi-colour LCD screen display.

All models are software controlled and many may be updated to the latest software revision as it becomes available. MSD 100 models are available from $2370 including sales tax.

For further information circle 145 on the reader service card or contact Amber Technology, of Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 9975-1211 or fax (02) 9975-1368.

Small screen CTVs offer many features

Mitsubishi Electric has released two new small screen CTV receivers offering many convenient features.

Equipped with audio video (AV) terminals, the 34cm model CT14AM2 and 51cm model CT21AM2 can be used to play videos or even electronic games. And because they have built-in NTSC, you can play Laserdisc movies or videotapes from friends and relatives who live in countries where NTSC is the TV format (for example, the US and parts of Asia).

The portable 34cm model (CT14AM2) also has an innovative optional tilt and swivel stand like a computer monitor, for added viewing flexibility. This allows the set to be moved up, down or sideways to find the most comfortable viewing angle. Both TVs are attractively styled and feature sleek rounded edges.

The RRP for the CT14AM2 is $399, with its optional tilt and swivel stand a further $19.95; the RRP for the 51cm CT21AM2 is $749. Both sets are available nationally from leading department stores and electrical retailers.

For further information circle 141 on

the reader service card or contact Mitsubishi Electric on (02) 9687 7777.

New video line doubler from Faroudja

The new Faroudja LD200-U Line Doubler is specifically designed for high-end home theatre and corporate boardroom applications. The latest Faroudja technology in the LD200-U converts standard PAL or NTSC video signals from any direct broadcast, satellite, video tape or video disk sources, into high definition images that have the look of film.

Scan lines are effectively removed through the line doubling process. Patented circuits eliminate aberrations and edge blurring and reduce noise, while also improving picture detail and colour.

This new model features new elegant packaging featuring infrared remote control and on-screen graphics displays. New circuit board designs reduce overall size with no compromise on performance quality.

By combining broadcast quality circuitry and user friendly controls, the LD 200-U Line Doubler is claimed to provide an unparalleled film-like theatre experience that can be easily integrated into any large screen viewing environment.

For more information, circle 143 on the reader service card or contact Trace Pacific at 8 Prohasky Street, Port Melbourne 3207; phone (03) 9646 5833 or fax (03) 9646 5887.

Dolby AC-3 Surround decoder from Onkyo

Onkyo claims that its new ED-901 AC-3 Decoder transforms today's most advanced AV surround receivers into the next generation of digital home theatre reproduction systems, based on the Dolby AC-3 digital surround sound system. The new Onkyo decoder also offers Lucasfilm Cinema re-EQ, which allows the listener to experience a surround soundfield tailored to Lucasfilm's own cinema standards, by properly tailoring the system's frequency response to accurately reproduce theatre acoustics in the home.

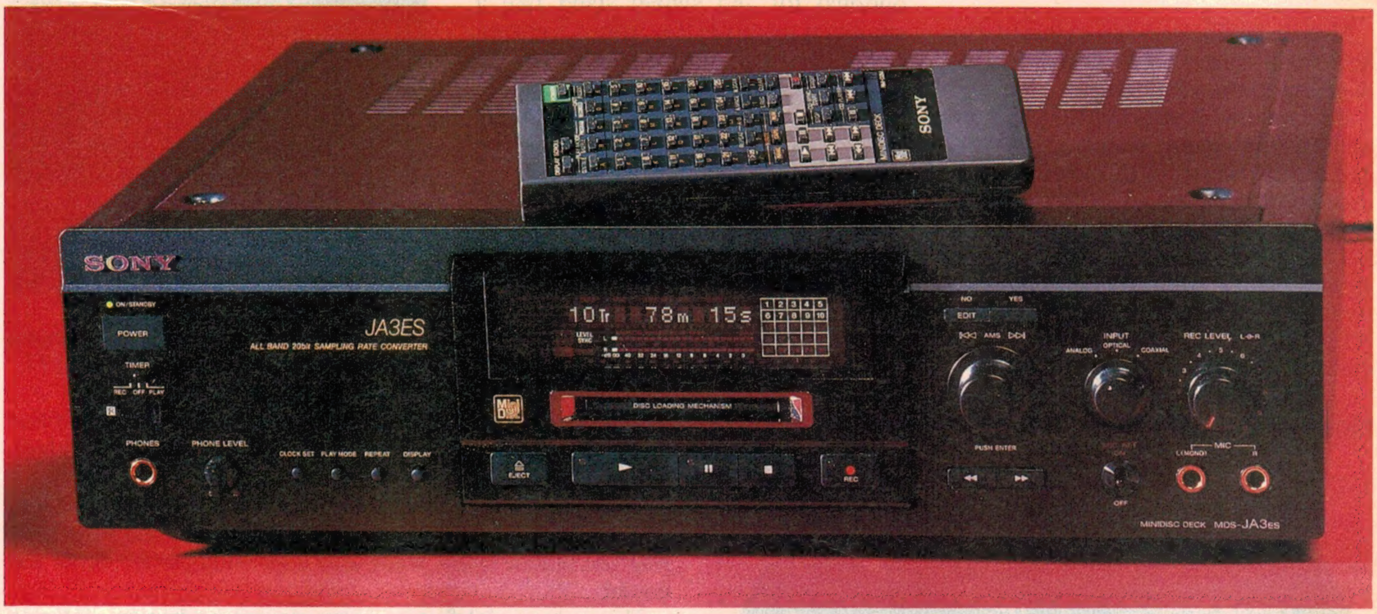
AC-3 differs from the widely used Dolby Pro Logic surround system in that it uses '5.1' discrete channels of audio information, featuring two completely independent surround channels with the same full-range fidelity of the front left, centre and right channels. As a result, Dolby Surround Digital achieves greater realism by improving depth, localisation and overall soundfield imaging. Currently, Dolby Surround Digital is installed in some 600 of the more than 30,000 Dolby-equipped theatres worldwide.

The new ED-901 gives home theatre enthusiasts a logical upgrade path to AC-3 surround technology, as it can be added to an existing compatible receiver, such as Onkyo's TX-SV919THX and the new TX-SV828THX, at any time.

AC-3 sound sources are currently available from specially equipped Laserdisc (LD) players, such as Onkyo's DX-V500, and the new digital video disc (DVD) players.

Features of the new ED-901 include: two input sources for audio and S-Video sources; optical and coaxial digital inputs as well as an RF input; easy connection with the host receiver via a single D-SUB 25 cable; a novel 'Midnight Theatre' function for late night listening at low volume but will full surround effects; the Lucasfilm Cinema re-EQ function; 20-bit D/A converter; and front panel operational status indication.

The Onkyo ED-901 is supplied in a black finish, measures 455 x 90 x 320mm (W x H x D) and is expected to carry an RRP of $1199. For further information circle 140 on the reader service card or contact Amber Technology of Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 9975-1211 or fax: (02) 9975-1368. ❖



SONY'S NEW JA3ES MINIDISC DECK

This month our reviewer Louis Challis was able to test and listen to the new MDS-JA3ES MiniDisc Recorder, the first of Sony's 'third generation' MD products. Its features include 20-bit performance, improved ATRAC digital compression/expansion processing and an impressive six-second recording delay, and Louis predicts that it's likely to trigger an immediate re-evaluation of the way the market ranks current audio recording technologies...

Three years ago when I received Sony's first generation MZ-1 MiniDisc Recorder, I was impressed by its flexibility, convenience and by its friendly features. Notwithstanding my impressions, though, it appears that relatively few others shared my enthusiasm. In the ensuing three years, to its chagrin, Sony has faced a less than captivated marketplace. Sales of MiniDisc hardware, and more disturbingly the all-important software, have apparently been disappointing.

Around about a year after the release of the MZ-1, Sony produced its second generation MiniDisc decks which were smaller, smarter, and considerably cheaper than the first generation. But otherwise not much changed, and the response of most consumers might well be described as a big 'yawn'. I can well imagine how depressed Sony's marketing personnel must have felt at that time.

Now if it were you or me, we would most probably have dropped the whole concept and moved on to what we perceived as being greener pastures. That however, is not the way Sony responds. With an unbridled tenacity, its engineers initiated the development of their *third generation* MiniDisc deck — as much as to say, 'we are right and you are wrong'.

If you've started yawning again, I recommend that you don't. It would be very wrong to think that this new-generation MD product is like its predecessors. The MDS-JA3ES is smart. It's precisely the sort of techno-toy which can induce (if not seduce) a reviewer, or a purchaser to change his or her mind about what's smart, what's innovative — and most particularly, what he or she would like in his/her Christmas stocking...

As a serious user of sound and music recorders for more than 30 years, I guess I have had a better opportunity than most readers to evaluate almost all of the different types of tape and magnetic recording systems that have been developed during that period. Whilst I have seen a number of transient arrivals, and even more rapid departures of recorders during that period, none of them has had the attributes and performance capabilities of this current new generation of MiniDisc decks.

In June of this year I would have assigned the following ranking for the four most important consumer audio recording systems:

1. Digital Audio Tape Recorders (DAT), whose primary attribute is its dynamic range, and previously unrivalled frequency response.
2. MiniDiscs (MD), which have similar attributes to DAT, with one major attribute of superior convenience, and one minor perceived liability of marginally inferior fidelity.
3. Digital Compact Cassettes (DCC), which have similar electro-acoustic characteristics to MiniDiscs, but have the perceived liability of slower response to major tape transit changes.
4. Compact Cassettes, which although now 'long in the tooth', have displayed a slow but relentless improvement in performance, after many years of constant development.

However having now assessed the new JA3ES MiniDisc deck, I have immediately revised those rankings. This review explains the underlying reasons for my changed perceptions.

Six-second buffer

Before the editor and I decided to review the JA3ES deck, Sony's marketing personnel described some of its more unusual features. They informed me that this deck has the ability to record six seconds of sound data, before you actually take the final step in the recording start sequence.

Sounds wacky? Well, I guess it might. And of course as always, there has to be a

catch — when you think about it, how can any recorder anticipate what you want to do? Well, the catch in this case is that in order to achieve that goal, you need to have taken a previous step in which you pressed the RECORD button, and the recorder was waiting in the PAUSE mode. The recorder can then sit in that state for as long as you like, awaiting your activation of the remote control, or the button on the front of the deck. While it is waiting, it is continually cycling six seconds of data through what is in effect a modern day complex digital version of what used to be described as a 'bucket brigade' memory. In other words, it always retains six seconds' worth of audio in its recording buffer...

At first I was sceptical, and queried the objectivity of the claim. But after a few carefully contrived tests, I confirmed that this was no idle boast; the recorder does precisely what is claimed.

You can actually record the data you have just heard coming over the radio, or your baby's first words, and avoid the need to sequentially record hours or days of a special occasion or a critical, transient 'never to be repeated sound', that previously you had no other convenient way of recording. I can't begin to count the number of occasions on which I needed that capability, and simply did not have it available in the recorder with the dynamic range, flexibility and convenience that the JA3ES now offers.

Many is the time I've wished I had this feature available, and Halleluiah — it's now available. It's also supported by a multitude of equally exciting features.

20-bit processing

The second exciting feature in this deck is its adoption of a 20-bit processing technology. Sony originally developed the 16-bit ATRAC system, which stands for Adaptive Transform Acoustic Coding. The ATRAC system provides effective compression of the original information density, without degrading the audible signal in terms of its quality. Sony has now made further advances in their fundamental DSP technology, so that instead of being a 16-bit ATRAC system the JA3ES now incorporates a much more potent and far more exciting 20-bit ATRAC system.

The JA3ES deck uses Sony's new CXD-8505Q D/A converter chip, which was developed for their latest generation CD players. This chip accepts a 20-bit digital data stream, which is converted by CXC-8505Q's first stage into an equivalent 22-bit signal, before passing it to the second stage which converts it into a stream of one-bit PWM pulses.

The PWM output of the chip is an audio signal with a spectacular dynamic range and a degree of fidelity which convinced me that any previous claims of lack of fidelity and commonality of quality between MiniDiscs and CDs has now become a technically invalid issue.

Although Sony claims a theoretical 131dB signal to noise ratio; I believe that what they were actually aiming to achieve was the linearity of an 18-bit system (i.e., 108dB capability). On delving further, that belief was confirmed by my measurements.

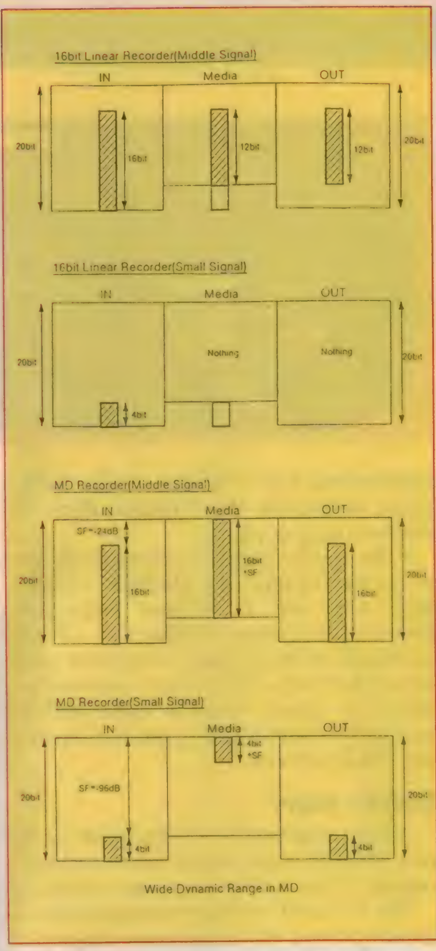


Fig.1: Diagrams provided by Sony to illustrate how the new MiniDisc signal processing uses a scale factor to achieve an effective 20-bit dynamic range, even though the media range is only 16 bits.

The recording side of the JA3ES deck employs a CXD8539M Sigma-Delta oversampling analog to digital converter. This chip incorporates a 'decimation filter' plus a high pass filter which effectively eliminates clock noise. As I will describe more fully later, I am satisfied that the system works as well as claimed.

Improved DSP chip

The next major advance is Sony's development of a new high performance DSP chip, the CXD-2536AR, for the ATRAC sound processing function. The outstanding feature of this chip is its ability to convert input and output signals with a full 20-bit dynamic range.

The way Sony has achieved this is through the adoption of a canny floating point coding procedure, in which the position of the signal data is selectively scaled up or down by means of the DSP scaling feature.

Sony quietly acknowledges that this dazzling chip was developed in conjunction with another 'unnamed semiconductor manufacturer'. Precise comparison between ATRAC and a conventional linear system is difficult, because ATRAC converts signals on the time axis into the frequency spectrum before it transmits data. Using the highly accurate computational techniques of the floating-point method, the dynamic range is wider. The concept behind this is described below:

A 16-bit linear recorder eliminates the lower bits of middle order signals, no matter how wide the input bits are. This results in some degradation in the input signal. In comparison with this process, the MiniDisc maintains the precision of 16 bits as they are received, and raises the level if the lower bit signals are well down in the dynamic range, recording their maximum values as a SF (Scale Factor) function. When these signals (with their 6-bit SF data) are subsequently replayed, their absolute level is returned to the original (relevant) level, at the time of recording. Therefore, so long as they are correctly computed, and correctly scaled, the 16-bit precision resolution can be maintained for signals encompassing a 22-bit dynamic range.

When a recording a low-level signal, a conventional 16-bit linear recorder eliminates signals whose peak levels fall outside (below) the conventional 16-bit dynamic range. When that occurs, you have no signal output. The JA3ES however, records those signals by increasing their level (and their scale factor), in order to incorporate them into a semi-conventional 16-bit signal range. On playback, they are reduced to their original value but the overall dynamic range achieved is better than 18 bits, and based on my evaluation, most certainly approaches 19 bits.

The advantages of this data re-scaling approach are displayed on the attached graphs (Fig.1). As you will observe, by recording the scale factor with the data (and ignoring the impact of residual system noise which is still significant), the attributes are both positive, and as I later discovered, provide a superb unexpected clarity and fidelity.

As I delved further, I found other attributes in the system. The JA3ES incorporates improvements in its 'Bit Allocation Algorithms'. Although Sony don't provide a detailed and comprehensive description of this function, it appears that this improved algorithm achieves a higher bit resolution for both low and high frequency signals than is provided by the previous generation of MiniDisc recorders and decks.

The critical advantages of this algorithm are an improvement in the signal to noise ratio with a simultaneous reduction of both total harmonic distortion and noise. This was most certainly confirmed by my measurements.

Where the signals have a regular spectrum with a uniform signal density between the low and high frequencies, as typified for example by a squarewave, the remaining bits in the algorithm are allocated to the middle and lower frequencies. This provides

an immediate perception of reduced distortion, and is tied in with the adoption of a basic 20-bit processing signal in the type CXD-8505 digital to analog converter.

Sample rate converter

Whilst previous MiniDisc recorders could not handle digital signals with either 32kHz or 48kHz fundamental sampling frequencies, the JA3ES incorporates a new sampling rate converter which will accept the three different sampling frequencies. More significantly, this sampling rate converter provides output signals which are jitter free, through the adoption of an over sampling filter and a decimation filter, whilst still retaining a 20-bit accuracy for both time and level.

The JA3ES also incorporates a direct quartz synchronisation system which is tied back with a conventional phase locked loop (PLL), to match any of the three different sampling frequencies with which the digital signal inputs may be encoded.

One feature that becomes very obvious when you start to use the MiniDisc deck is the ease with which it can be used for direct recording from a CD player, a DAT recorder or any other digital source. As long as the other digital source has either a conventional coaxial digital output or an optical digital output, the MiniDisc deck will accept that signal. More significantly, it will interpret the signal correctly, and will record its own signal with a 44.1kHz sampling frequency, independent of the original sampling frequency.

During the subsequent signal processing the deck will encode each successive track with either the original track number, or the track number corresponding to the incremental track number. If the source stops, or pauses, the MiniDisc deck will similarly stop or pause.

If the source material comes to the end of the disc or tape, the MiniDisc will similarly stop and await your instructions before proceeding further. It adroitly avoids all of those nasty functional problems which you and I have experienced, when the source material stops, and the interconnected recorder continues recording blank material.

Inside story

A brief examination of the inside of the new MiniDisc deck reveals that it contains a number of unusual and innovative features.

The first, and less than obvious technical feature, is one which has been adopted by a number of other Sony Extremely High Standard (ES) series consumer products: a neat and remarkably effective R-core Power Transformer. The 'R' stands for *round*, as this power transformer uses an elliptical cross section for the iron core.

The advantage of the almost round profile is that it facilitates the use of a high wire winding tension. The primary attribute of this approach is that it reduces transformer vibration. Sony also claims that it simultaneously reduces magnetic flux leakage, although I was unable to confirm this.

There are a number of other neat technical features visible inside the deck. The first was the extent to which special multi-lead ribbon cables and electrically screened ribbon cables have been used to interconnect the seven separate printed circuit boards and the MiniDisc drive. Some of these ribbon cables have as many as 30 separate conductors, and one of the boards has as many as six sets of multi-lead ribbon cables connected to it. The high technology in this deck is located in the LSI chips, and with one exception, they all appear to be manufactured by Sony.

An examination of the outside of the deck reveals that the only controls which differ to any significant degree from your existing CD player or cassette deck is this deck's adoption of the 'Large Multi-Jog Dial'. The dial provides users with quick and convenient access to the table of contents (TOC) display. Having selected the correct TOC track number, you can either play it, edit it, or over-record a single track or all tracks, as and when required.

The other relatively unusual controls and functions provided on the front panel are firstly the provision of a pair of conventional 6.5mm diameter tip and sleeve microphone sockets, which will accept either a single or two microphones, to provide the inputs to the two channels. The second unusual feature is the provision of a 20dB input attenuator, so that either high output microphones or other inputs may be fed to the microphone circuit.

Objective testing

Having identified all the functions and controls, I proceeded with an objective assessment of the JA3ES deck. I wasn't surprised to find that the record to replay frequency response is particularly flat, with a gentle rise of +0.7dB at the top end, and

A view inside the JA3ES deck. The main digital processing board is to the left of the MiniDisc mechanism (upper centre). Note the compact R-core transformer, at lower right.

an equally gentle droop of -0.2dB at 10Hz and -2dB at 2Hz.

With analog input the measured signal to noise ratio is -98dB(A), and -89dB unweighted. An examination of the noise level recording reveals that the only significant intrusive components are a dominant peak at 100Hz (-90dB), with less pronounced peaks at 200Hz and 300Hz.

The digital record to replay spectrum, is significantly cleaner than that using the analog input, as they contain no trace of mains hum or harmonic components at 100Hz, 200Hz and 300Hz.

An examination of the noise thresholds with our FFT analyser using an ultra-pure 1kHz sinewave signal at -63dB reveals that the residual noise components are at least 50dB below the fundamental signal component, and are thus totally inaudible. The combined effect of the ATRAC system and the frequency scaling capabilities of the deck ensure that low level signals maintain their fidelity and an exceptional signal to noise ratio performance, even when they are 60dB below the peak recording level.

The crosstalk between left and right channels with analog inputs are -90dB at 100Hz, -93dB at 1kHz, and -76dB at 10kHz, which is a particularly impressive performance. The record to replay linearity is within 0.1dB all the way to -70dB, is 0.2dB high at -80dB, and 0.5dB high at -90dB — a performance which few CD players can currently match.

The distortion characteristics with analog input remain at insignificant levels, which are basically below the noise threshold of the equipment (determined by the ATRAC encoding), all the way down to -90dB, at which point the residual system noise still remains the dominant factor. All other significant parameters including wow and flutter, and transit speeds were impeccable.

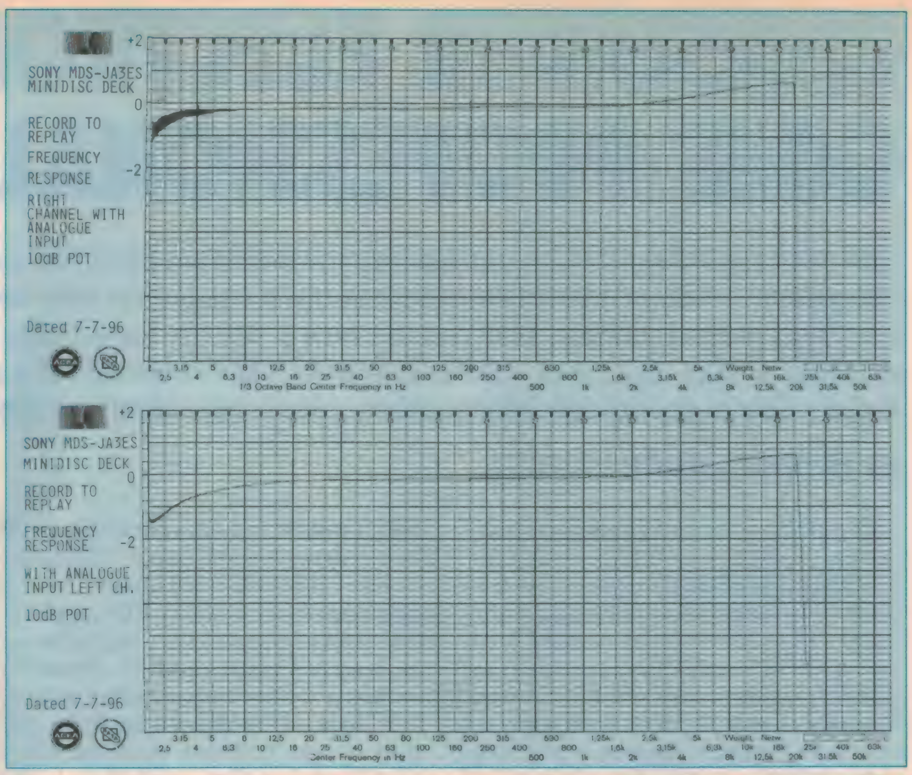
Listening tests

From the objective testing I progressed immediately into a subjective evaluation of the JA3ES deck.

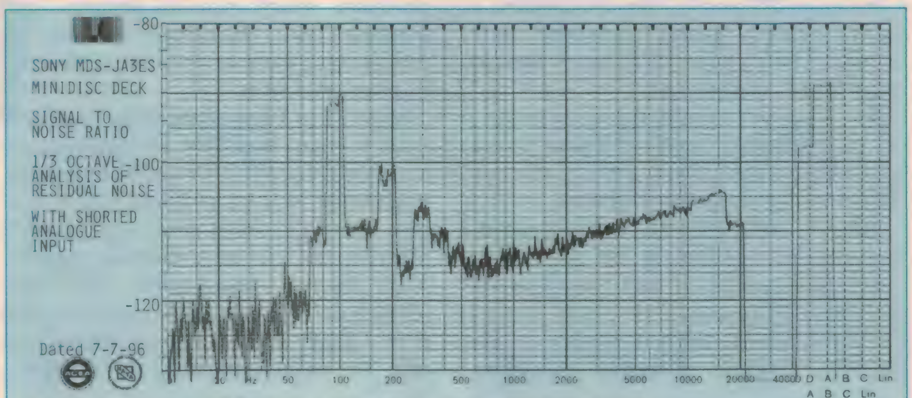
The first test was to record selected samples from a demonstration disc prepared by Sony, entitled 'Super Bit Mapping Demonstration Disc' (SBM 1). I used the coaxial digital output from my CD player to provide a direct digital input to the MiniDisc deck.

The SBM 1 disc contains some unusually low level test signals, whose transient peaks lie in the range -70dB to -80dB. Signals whose peak levels are as low as that, and whose average levels lie in the range -80dB to -90dB, constitute particularly difficult material to re-record with an adequate signal to noise ratio. To my surprise and pleasure, the JA3ES had no difficulty in achieving that goal, and we were incapable of detecting which was the original CD and what was the copied MiniDisc material in a double blind test.

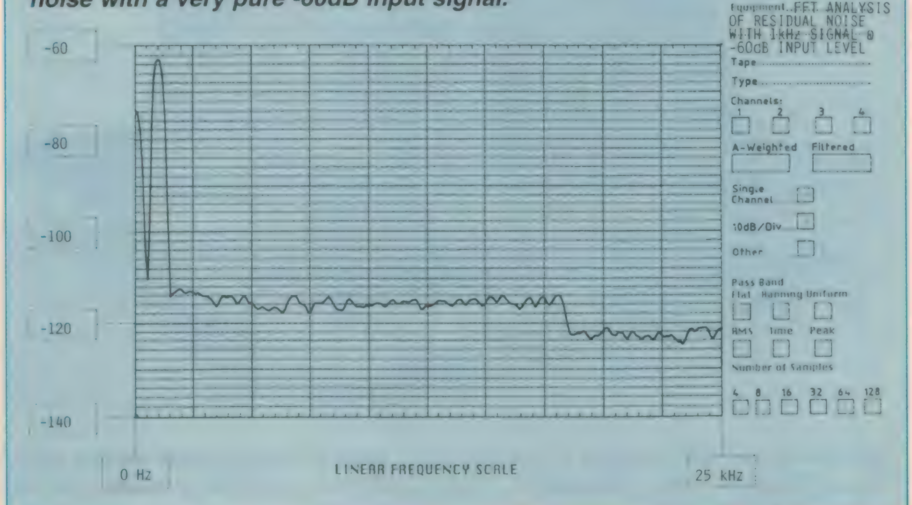
(Continued on page 101)



Above are plots showing the measured overall record-replay response of the two channels of the Sony MDS-JA3ES deck, using the analog input.



Above is the residual noise with shorted analog inputs, measured using 1/3 octave filtering, while below is the noise with a very pure -60dB input signal.



CONSUMER ELECTRONICS GOES PROFESSIONAL?

The success rate of consumer electronics manufacturers has not been too impressive in the last few years — few of their new products have caught on with the public as well as the audio CD and VHS video recorder. Many of the new products have been more successful with professional users, in fact. But what *are* the characteristics required for a product to gain consumer acceptance? The author of this article offers some interesting suggestions...

by HUGH CLEVERLY, B.Sc.

The market for new consumer electronics products has not been easy for manufacturers to predict in the last few years. Ever since the introduction of the audio CD and the VCR, there have been few really successful new products. The games machines from Nintendo and Sega have probably had the most success, with the home computer, including a CD-ROM and now Internet access, also coming along quite nicely. The 'home cinema' with surround sound and ultra large TV screen has also created a small market, among customers with enough money to pay for it and room in their homes to install it.

But large number of products brought to the consumer marketplace in recent years have failed to catch the public eye and create a 'must have' attitude.

RDAT, the digital audio tape recording system, fell foul of the politics of copyright protection and failed to be accepted by consumers when it was finally released. Sony's MiniDisc and Philips' Digital Compact Cassette (DCC) have not made a great impact on the consumer market. Super VHS failed to take off with consumers as an improvement on ordinary VHS, and Hi8 was similarly placed as a replacement for Sony's Video8. Kodak's PhotoCD has had a similar lack of public appeal. The 30cm (12") video LaserDisc had some success in North America, but a more limited market penetration in the rest of the world.

But the surprising thing about these products, which were all designed and marketed with consumers in mind, is that most of them have been taken up by *professional* users.

RDAT has been taken up as a replacement in many areas for 1/4" analog tape recording. In radio, TV and even recording studios, RDAT is found where 1/4" tape was used a few years ago. Sony's MiniDisc has found a place as replacement for the 'sound carts' (1/4" tape cartridges) that most radio stations used a few years ago (many of course still do). TV stations also use the MiniDisc where they would have used 1/4" tape some years ago.

Super VHS has been used by corporate video departments in place of their low band Umatic recorders, and by the better wedding video makers in place of their ordinary VHS camcorders. Hi8 is used by some TV stations as replacement for more expensive cameras, in dangerous situations where the lesser quality pictures are outweighed by the possible cost of replacing a $40,000 to $60,000 Betacam. Some TV stations around the world use Hi8 almost exclusively to capture their news footage. Kodak's PhotoCD has found a ready acceptance among professional photographers and publishers. The video LaserDisk found some use in corporate training and information storage.

The only real exception seems to be Philips' DCC, which doesn't seem to have had much acceptance in professional circles.

Few consumer electronics products have been as successful as the audio CD, particularly when teamed up with compact portable players like the Sony D-100 Discman.

Why so?

But why *have* products which were conceived as domestic products been largely ignored by the the public they were aimed at — yet taken up with relative enthusiasm, once they had overcome the perception that these were only domestic or consumer toys, by professionals?

Once the audio CD had become accepted by consumers and professionals alike as the replacement for vinyl LP records, and was widely used, it automatically became the standard home replay system by which all other systems had to be judged. As a consequence, no new consumer hifi product could be considered for marketing unless it sounded at least as good as an audio CD.

The CD specifications were, overall, better than those of most professional equipment available at the time. So once

What of the new Digital Video Disc (DVD) system, which uses advanced digital compression technology to pack a complete movie (with surround sound) onto a 120mm CD — will it be a success with consumers, or not?

it was obvious that the buying public was not going to purchase the new products in great numbers — and there was some interest from professional users — it was easy for manufacturers to modify their products to professional standards by making the mechanics more robust, the electronics more sophisticated and the operational controls more acceptable to professional operators.

Kodak's PhotoCD does not come into this category because it had more quality built in to the design than consumers were likely to need. The video Laserdisc had its limited acceptance because it filled a need.

But what makes one product succeed in the consumer market, when others don't inspire the public to part with their money? I have a few suggestions that try to explain this.

It appears to me that a new product will succeed if it is *either* something that has not been available before and is useful, *or* it is better than that which is available when it is introduced and has advantages over the current models and the price is acceptable to the consumer.

Lets see how this applies to the recent successes.

When it was introduced, the audio CD had better quality than anything heard before (except for FM radio) and was very easy to use. You could select any track you wanted without dropping a needle onto the surface and risking damage; you could repeat tracks; you could play a CD all the way through without having to turn it over; all automatically and using a remote control.

CD's were small and easy to store and were advertised as being almost indestructible. The CD was better than anything that was available and, even though it could not record, it had advantages and it succeeded.

The VCR was a new product. You could now record TV programmes and watch them when you wanted to; you could fast forward through the commercials; you could even record the TV when you weren't there and you could operate it from your armchair with a remote control. Eventually you were able to watch your own or someone else's home movies on it. It was not available before, and it was useful and it succeeded.

But how does this apply to the less successful products?

RDAT was introduced after a long battle over copyright issues. It had the same sound quality as a CD, but it had been forced to include a copy protection scheme in its electronics — which put up the price. It was an improvement on the CD only in that it could record, but its recording abilities were limited by the copy protection.

Unlike the CD, however, RDAT was a linear recording medium. That is, you had to search backwards and forwards along the tape to find any bit that you wanted. This is made easier by the inclusion of a time display and index marks, but you still need to have notes of the times of what you have on the tape in order to find anything. The tape then takes time to be wound through to that spot, before it can replay what it finds there.

There are consumers who want to make their own quality sound recordings, but they are not large in numbers. The mass market does not want to fiddle about with plugs and cables, it wants to be able to use a product out of the box and for it to be easy to operate and be reasonably priced. RDAT's introductory price was too high for most. It provided an improvement in sound recording quality, but it had too many disadvantages.

Much the same could be said about Sony's MiniDisc, although it overcame

Although quite popular in the USA, analog video LaserDisc players have not been markedly successful in most other countries — why?

the linear problem by being a non-linear recording medium. That is, like a computer disc, it goes to whatever file you tell it to and plays it almost instantly. But the fact that recording was now more complex than just hitting a record button made it appeal more to the computer buff than the ordinary consumer.

MiniDiscs sounded like CD's and there were pre-recorded titles for sale. It was advertised as being able to used by joggers, with no loss in playback when bumped up and down. The built-in memory buffer was supposed to sort that out. Perhaps there weren't enough joggers in the world to create a market.

The MiniDisc was small, easy to store, perhaps too easy to lose, looked too much like a computer disc and, at the price it was introduced, was not sufficiently different from a CD in concept to create its own market among ordinary consumers.

Philip's DCC probably suffered from being too much like the compact audio cassette that it grew from. Most users would have experienced the hissy quality, wow and flutter from dirty mechanisms, cassettes being stuck in the player, tape jamming and unwinding into the machine. Even though they were small and easy to store, it was virtually impossible to find any particular track on them without a great deal of patient winding and rewinding.

With a cassette similar in size to existing analog compact cassettes and backward compatibility, the Digital Compact Cassette (DCC) was expected to succeed — particularly with high end decks like this Technics RS-DC10. Until now, though, DCC hasn't really caught on with consumers.

DCC provided a great improvement in terms of both audio quality and track location, but had too much baggage from its predecessor and the introductory price was too high.

Super VHS and Hi8 gave better quality pictures than the VHS and Video8 formats they improved on, but the ordinary consumer could not see a sufficient amount of improvement on their TV sets to justify the high cost of replacing their VCR. Also they couldn't share tapes with friends who had not upgraded their machines, because Super VHS tapes would not play on ordinary VHS recorders and few super VHS tapes could be hired from video libraries. Consumers could not see a worthwhile improvement for the price they were being asked to pay and there were disadvantages.

RDAT recorders like this Sony TCD-D3 DAT Walkman haven't been a success with consumers, but are now used by many audio professionals.

And new products?

How does the experience of these recent consumer products indicate which way current offerings will go? Let's consider DVC and DVD for example.

DVC is a digital video recording system introduced to replace VHS and Video8 using 6mm tape. It will be incompatible with existing formats, and so will require a new machine. What advantages will it offer? Better quality pictures for sure, but SVHS/Hi8 gave us that. DVC will be better in quality than SVHS/Hi8 — up to broadcast quality is claimed — and copies should not lose any of that quality.

But what proportion of the mass market wants to make copies of their recordings? Most can't connect the inputs and outputs of today's VCRs to make a copy.

So is DVC destined to be confined to semiprofessionals and serious hobbyists, as was SVHS/Hi8, or will DVC be a cheap replacement? Will there be DVC videos for hire and how will they compete

Sony's MiniDisc system hasn't fared too well with consumers either, as yet, despite becoming widely used by professional users...

with DVD for shelf space?

Now consider DVD or Digital Video Disc. This is a development on the CD-ROM, that has the potential to store full length movies on a CD-sized disc. Home computers, with the addition of an MPEG card and a suitable audio processor, will be able to play these discs, as will purpose-built boxes that plug into your TV set.

The picture quality will need to be better than VHS, to succeed in the consumer market. This will automatically mean that the quality will be better than computer users put up with now, when video is displayed on their monitors. So it should appeal to computer users. But it remains to be seen what picture quality the MPEG compression system will provide on TV sets.

As well as playing films, the DVD will also be interactive and so behave as a larger storage capacity CD-ROM. It is also suggested that the DVD players/drives will be able to read audio CDs and todays CD-ROMs. They will have multi-channel audio capability and surround sound. But they will not be recordable, at least not for some years.

DVD could be introduced as the video version of both the successful audio CD and computer CD-ROM, and so benefit from their great success in the world market. It has several advantages of its own, even though recording is not one of them just yet. DVD *could* have a definite edge over DVC.

A wish list

Perhaps now is a good time to consider what sort of products we consumers *are* waiting for, that would become a 'must have' product...

How about an LCD video screen that could be carried anywhere, with enough memory built in to carry downloadable newspapers or magazines, or books, or (with headphones) music video clips? Or what if the same panel could be linked to a portable TV receiver or a portable DVD player, to take videos anywhere you wanted? Research is going on into a product of this sort, and into devices with stronger light output than the LCD to be usable in bright daylight.

How about LCD video goggles that could be linked to the same devices as the panel? These goggles would have the potential to project 16 x 9 aspect ratio, high definition and even 3D pictures, from DVD or a home computer or a future TV transmission. There are a number of alternatives to the LCD panel in development at the moment, which would need to replace the LCD in devices of this type — because LCD panels of the size needed for goggles may well show too much of the LCD structure to be accepted as high quality displays.

What potential future devices can *you* suggest to manufacturers, eager to get a 'must have' product to succeed?

NEC's MT600 LCD Video Projector

Well known for its TV receivers, video equipment and high quality computer monitors, NEC has just released an impressive new LCD video projector which incorporates the firm's MultiSync technology and can display either video or computer graphics with equal ease. Boasting a 250W metal halide lamp and high efficiency optics, it can deliver brilliant colour images of 400 ANSI lumens, with a contrast ratio of 200:1.

by JIM ROWE

With the current emphasis on 'home theatre' installations, there's a renewed interest in large-screen video displays. And of course for the largest and most impressive video displays, at least as yet, you really need a video projector.

Up until a few years ago, the only kind of video projection technology that was readily available and even vaguely affordable has been that based on projection CRTs — small tubes of the same basic type as used in standard TV receivers and computer monitors, but run at much higher voltages to get an extremely bright picture. A lens system then projects this ultra-bright image onto the viewing screen, either from in front of the screen (front projection) or behind it (rear projection).

While capable of producing a large and bright image, these CRT-based video projectors are relatively big and heavy. A colour projector of the portable 'front projection' type also tends to be very fiddly to set up, as there are generally three separate CRTs — each with its own lens. This means that whenever the projector or screen are moved, a fairly tedious adjustment procedure is necessary to get the three 'colour component' images back into accurate alignment on the screen.

The solution to this last problem really had to wait until the development of the modern LCD video projector. Instead of a trio of CRTs with separate lenses, this generally uses a trio of three small LCD (liquid-crystal display) panels sharing a single optical system. The LCD panels are of the transmission type, and act rather like 'dynamic slides', passing the light from a high

efficiency metal halide lamp. Mirrors and filters split the light into the three primary colours, which then pass through the LCD panels and are finally recombined again to pass through the single high quality projection lens.

Thanks to the integrated optical system and single projection lens, an LCD projector has no complicated user setting-up procedure. The projection lens is generally of the variable focal length or 'zoom' type, to allow convenient adjustment of image size for a given projector-screen distance, and with the better projectors both focussing and zooming can be controlled remotely. It's all very convenient.

In fact perhaps the only real disadvantage of LCD projectors, until very recently, is that their image resolution has been limited. This has made the individual pixels fairly obvious (particularly when the projected image occupies a relatively large visual angle), detracting from the visual impact. But as projectors like NEC's new MT600 demonstrate, this disadvantage is now rapidly fading into history.

All of the input/output connections for the MT600 are found beneath a swing-down panel on the side. It handles a wide range of different RGB and video input formats.

Light & bright

Of course NEC has a great deal of experience with TV receivers and video equipment, and its MultiSync CRT monitors have an excellent reputation in the computer industry for both performance and reliability. So it's not surprising that they're playing an important role in developing video projector technology as well.

The company claims that at 400 ANSI lumens, the light output from the new MT600 is 50% higher than similar sized units from competitors. It uses a 250-watt metal halide lamp, with a colour temperature of 7500K and a rated operating life of 2000 hours. Three high efficiency 33mm-diagonal TFT (thin-film transistor) active matrix LCD panels are coupled to a fast F3.5 power zoom projection lens, with a range of 52 - 73mm. The optical efficiency or 'aperture ratio' of the LCD panels is 67%, and this results in an overall contrast ratio of 200:1.

The high light output, together with the MT600's zoom lens allows it to give bright, clear images variable from 50.8cm (20") diagonal at a distance of 1m, up to 762cm (300") diagonal at a distance of 12m. And both focus and zoom are remotely controllable, along with various other display functions.

The image resolution achieved by the MT600 is 640 x 480 pixels, corresponding to 'VGA' resolution in computer parlance. However built into the projector there's quite a bit of fancy microprocessor-based MultiSync electronics, and this allows it to display a variety of different computer graphics and video formats.

For example it can display 640 x 480 pixel RGB images from a PC at vertical refresh rates of 60, 72 or 75Hz (horizontal 15.73 - 39.38kHz), or from a Macintosh at 67Hz. It can also display 800 x 600 pixel 'SVGA' images in 'compressed' form, at refresh rates between 56 and 60Hz.

On the video side, it can display either standard composite video or S-Video, in a choice of NTSC (3.58MHz or 4.43MHz), PAL or SECAM formats. With a video bandwidth of 32MHz, the nominal horizontal resolution for 3.58MHz NTSC is 550 lines, while that for PAL, SECAM and 4.43MHz NTSC is 350 lines. The colour (hue/saturation) resolution is 24 bits, or 16.7 million colours.

There's also a built-in stereo audio amplifier, with an output of 1W/channel, together with a pair of small speakers.

For RGB input from a computer, the MT600 has a choice of both compact (3 x 5) and standard (7 + 8) 15-pin input sockets, with a switch so that only one can be used at a time. However the socket that is not used for input can be used as a 'through' RGB output, to drive another monitor or projector. Computer audio input is via a 3.5mm mini stereo jack.

Composite video input is via an RCA socket, while the S-Video input is via the usual mini 5-pin socket. A pair of further RCA sockets is provided for the accompanying stereo audio.

Additional input/output connectors include a mini 8-pin socket for direct PC control, a 3.5mm stereo audio output jack, a DC power output socket providing 12V at up to 400mA, and a 3.5mm jack which can be used for hard-wired connection of the remote control — as an alternative to using IR linking.

Now that we've mentioned the remote, this is a fairly impressive paddle-shaped unit which provides a wide range of functions. As well as allowing you to adjust the projector's focussing and image size (zoom), it also gives you the ability to select between the RGB, video or S-Video inputs, to adjust image brightness, contrast and colour saturation, to vary the sound volume, to 'freeze' the image or mute the sound, to select either 'normal size' display or a choice of 2X or 4X electronic magnification, to move some RGB images laterally and/or vertically, and even to turn the projector on and off.

That's not all, either. The remote can also double as a computer mouse, with a large circular 'tilting button' and an adjacent 'click button'. With matching IR receivers plugged into your PC or Mac, this allows a presenter to control the computer's operation without having to return to a desk or podium.

In short, the remote control is a pretty nifty unit, and adds a great deal to the MT600's ease of use for presentations. (The MT600 itself has IR sensors at both the front and back of the case, for

added flexibility.)

By the way, the top of the projector case itself has some control buttons, which allow you to control power on/off, focus, zoom and other functions. However apart from initial setup, it's generally easier to use the remote control.

The size of the MT600 is a compact 322 x 407 x 150mm, including feet and the protruding part of the projection lens. It also weighs only 7.2kg (16 pounds), making it quite convenient for portable use. The feet on the front (lens) side of the case are adjustable, by the way, to allow fast and convenient setup.

Trying one out

NEC Australia very kindly made an early sample of the MT600 available to us for a couple of weeks, to try it out for ourselves. We were able to try it out with a couple of different computers, and also a variety of different video sources including off-air PAL, and both PAL and NTSC from LaserDisk and tape. We also tried it in a variety of ambient lighting conditions — daylight, fairly strong artificial light, and in a darkened 'home theatre' environment.

There were no problems at all in setting up the projector for any of these situations, and generally it gave a very good account of itself. The brightness was excellent, and even with an image size of 1500m the viewing contrast was impressive even for normal 'room in daylight' or 'strong artificial lighting' conditions.

The remote control of both zooming and focus was very smooth and convenient, and in fact this also applies to just about all of the control functions.

When it comes to image resolution, we're happy to admit that the MT600 delivers as smooth and sharp an image as any LCD-type projector we've yet seen. However when the image size is increased to subtend a reasonable viewing angle, the individual pixels *are* still visible, and tend to impose their own 'screen' pattern. With some computer images this even produced some noticeable Moire beat patterns...

Our impression is that while this won't detract from the appeal of the MT600 for large-screen computer presentations, or even for many video situations, it will tend to make it less than entirely satisfying for high-end video and 'home theatre' applications.

We understand that before the end of the year, NEC will be releasing another new model, the MT800, which will be almost identical to the MT600 except that it will offer a true 800 x 600 pixel resolution and a slightly reduced light output (350 ANSI lumens). This sounds as if it will be the preferred unit for those wanting that 'little bit more' in terms of image resolution.

Other than that, though, we were really very impressed with MT600 — or we would have been, if we'd have let ourselves be. That's because the MT600 carries a pretty hefty price tag — currently no less than $14,495 including sales tax. Clearly it's going to be some considerable time before mere magazine editors can afford the luxury of big-screen home video!

The MT600 LCD Video Projector is available through NEC's appointed Pro-AV dealers in each state. For further information, on either the MT600 or your nearest dealer, contact NEC Australia's Home Electronics Group at 244 Beecroft Road, Epping 2121; phone (02) 868 1811 or fax (02)869 1112. ❖

SHORTWAVE LISTENING

with Arthur Cushen, MBE

Radio Nederland's Pacific relay base

Radio Nederland's transmissions to this area for the last 25 years have been dependent on their relay base on Bonaire in the Caribbean, which supplies us with an excellent service.

In 1953, international broadcasting was resumed in Holland with a tranmsitter at Lopik and this site continued to serve a world wide audience until the early 1960s, when plans were made to build a relay base on Bonaire, one of the three islands off the coast of Venezuela. The other two islands are Aruba and Curacao.

The Antilles, which formed the three islands, granted a licence to Trans World Radio in 1963 to build a medium and shortwave transmitting facility on Bonaire. When Radio Nederland was advised of this move, they contacted Trans World Radio with a proposal to relay some of the Radio Nederlands programmes into South and Central America. The use of TWR for the Radio Nederlands broadcasts commenced with a 50-minute broadcast each day and the programmes from Hilversum in Holland were sent by shortwave.

The ultimate goal on Bonaire was for RN to build its own facilities, and in March 1969 two Philips 300kW transmitters were put into service with an antenna array of Swiss construction. In 1978 the Bonaire relay station became a pioneer in receiving its material from Holland by satellite, and this improved the audio quality and the competitive role of the broadcaster. In 1989 a new 250kW transmitter was purchased and installed on the site.

There is a satellite receiving station outside the capital Kralendijk, which also houses the administration offices. The signal is received from Holland in digital form, then converted into audio and sent by cable to the transmitter site. The station has 14 antennas beaming towards West Africa, the Pacific, North, Central and South America.

In order to supply power for the station, five diesel generators have been installed. These generate a power of one megawatt and use 5000 litres of gasoline a day. The aerial towers are subject to corrosion from the salt water, and special protective paint has to be applied.

Due to the use of the satellite, which is able to feed other stations in the South American area, Radio Nederland now has a two-programme service and the radio stations in the area can receive the same high quality signal as is being rebroadcast from Bonaire. The use of this satellite signal by many stations in South America means that Radio Nederland signals are carried on medium-wave and FM in Spanish or Portuguese, to many local communities. The Bonaire facilities are backed up by a staff of 42.

Radio Nederland has similar relay facilities at Madagascar off the east coast of Africa, while in Holland a site at Flevo now carries the shortwave service. In recent years time has also been leased on many Russian transmitters, to boost reception in Asia and the Pacific.

The use of satellite communication between the studios at Hilversum and the various relay points throughout the world has speeded up the topicality of the broadcast. I can recall in 1966 I recorded my 'DX News' at RNZ studios in Invercargill from a Braille script and the tape was flown to Holland, put into a programme and then airmailed down to Bonaire. This meant that the material was a month old. Today Jonathon Marks of Media Network phones me as late as a Wednesday morning for my contribution and it is broadcast on Thursday evening to the South Pacific. This is the fastest service yet that a broadcaster could use.

Radio Nederland broadcasts to the Pacific at 0730-0830 on 9700kHz and 9720kHz, 0830-0930 on 9720kHz and 0930-1030 on 9720kHz, all from Bonaire. The last transmission is also carried on two transmitters in the former CIS, on 12,065kHz from Petropavlovsk-Kamchatskiy and on 13,710kHz from Irkutsk. Media Network is broadcast on Thursday at 0752 and 0952UTC. ❖

AROUND THE WORLD

AUSTRALIA: Radio Australia's latest schedule shows no changes at Shepparton, but some alterations at Brandon and Darwin, while Carnarvon has been deleted. The schedule indicates a new 300kW transmitter to be installed at Darwin, moved from Carnarvon. Radio Australia has cancelled the relay of the BBC World Service 2200-2300 on 11,695kHz.

DENMARK: Radio ABC, which has operated on mediumwave and FM for many years, has commenced broadcasting in shortwave on 7570kHz from 0800 on Sunday. Transmission extends to 1200UTC, programmes are in English and include music. The ABC DX Report is broadcast at 1130UTC. This is one of the most successful private radio stations in Denmark, which commenced operating in 1990. The transmitter being used is in Kaliningrad, with power of 120kW.

GUYANA: Georgetown, a new shortwave transmitter is now in operation using 5kW, while local time is now three hours behind UTC. The station operates 24 hours a day; from 0900-2100 on 5950kHz and from 2100-0900 on 3290kHz.

INDONESIA: RRI Jakarta is excellent at 2400 with theme, time signal and news. The station carries the National programme on 15,125kHz, while later in the day the National programme is heard around 1100UTC on 9680kHz and the International Service continues on 9525kHz.

ISRAEL: IBA Jerusalem's latest schedule indicates English from 0400-0415UTC on 7465kHz, 9435 and 17,545kHz; 1400-1430 on 12,077kHz and 15,615kHz; and 1900-1930 on 7465kHz, 9435, 11,605 and 15,640kHz.

MONGOLIA: Ulaanbataar is received with English 0930-1000 on 11,850kHz and 12,085kHz; 1200-1230, 1500-1530 and 1930-2000 on 9745kHz and 12085kHz.

RUSSIA: Voice of the Mediterranean has been received using a Russian transmitter on Sunday 0100-0400UTC on 15,480kHz and 17,590kHz and daily 1900-2100 on 9765kHz and 12,060kHz. The broadcasts are in English, French, German and Arabic and originate from the studios in Malta. The station is asking for reception reports and verifies promptly with a postcard showing scenes of Malta. The address for reception reports is PO Box 143, Valletta CMR 01, Malta.

SAIPAN: KHBI has made some changes in the service to New Zealand and is broadcasting from 2000-2100 on 9845kHz. The same frequency is used at 0800-0900UTC to this area.

SINGAPORE: Radio Singapore International's latest schedule shows broadcasts in English from 1100-1400 on 6015 and 6155kHz, with news every half hour. Friends of the Airwaves on Sunday at 1305UTC is a programme of conversation with listeners, amongst other items.

USA: KAIJ in Dallas, Texas is received at 0600 on 5810kHz with Dr Gene Scott, and still heard at 1000. The station announces its call on the hour, but the frequency suffers some radio teletype interference.

VATICAN: Vatican uses two transmitter sites, one on Italian soil and the other low powered inside the Vatican. Their schedule shows 1830-2000UTC on 4005kHz with 10kW; 0500-0700, 0945-1100, 1145-1230 and 1345-1750 on 5880kHz with 80kW; and 1345-1630 on 7250kHz with 30kW. Reception at 0500 on 5880 includes a broadcast in English directed to Africa. ❖

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 11 hours behind Australian Eastern Daylight Time and 13 hours behind New Zealand Daylight Time.

PAY TV: JUST HOW GOOD IS THE QUALITY?

Sports, movies of every vintage, news, cartoons, business programming, old TV series and you name it — Pay TV promises multiple choices. But do we get *quality,* along with the quantity?

by BARRIE SMITH

As we sit back, enveloped if not enraptured in the charms of the multiple channels of Pay TV now available, it is all too easy to accept the new technology as the absolute peer of the Free To Air (FTA) programming we have enjoyed now for 40 years.

For Pay TV to arrive in this country, it was necessary to provide a new means of transporting unheard of amounts of programming across our oceanic moats. In marketing terms, multiplicity of programming is Pay TV's 'USP' (unique selling proposition) and what sets it apart from FTA.

For example, Foxtel transmits 26+ discrete channels of broadcast material for 24 hours a day, seven days a week, 52 weeks each year — an amount of data that would call for unheard-of amounts of satellite time if the video material were sent in its original state.

Once the material is timed and scheduled, it has to be sent out — in Foxtel's case, on a fibre/coax network across the country, via neighbourhood telephone exchanges. Rupert Murdoch, CEO of News Ltd, co-partner with Telstra in the venture, has ambitions of 500 channels of Pay TV for the service — plus telephony, data transmission and two-way interactivity such as home shopping, banking etc.

You don't need to be an electronics whizz to realise such an enormous data conveyance task would be beyond any network. The answer, for Pay TV to become practical and commercially viable, was for the video and audio components of television programming to undergo some form of compression.

Arise, MPEG technology — in all its modes.

The US experience

Most of us have heard the horror stories about the US Pay TV experience, where some tiny regional operators deliver programming from banks of VHS VCRs, showing scant regard for their subscribers' critical expectations. One company in New Zealand ran a similar scheme for a while — using higher quality Super VHS machines.

Before Pay TV arrived here, similar stories ran riot in our expectant ignorance, quickly killed by pioneering operator Galaxy's confirmation that our regulatory and technical overseers would not allow such 'easy fixes'. In any case, viewers would immediately notice technically inferior programming that fell below the level of FTA.

Basically, the quality of Pay TV output has to equal that of the FTA stations. And, canvassing the three operators currently servicing the market, it has to be admitted there has been little complaint from the subscribing and viewing public. In many cases, the signal quality in the home is better than FTA; one bonus is that two of the three Pay operators also carry the FTA programming as a free service — which splashes up on the home set in interference-free form.

There are a few problems, but in the main these are outside the control of the Pay companies' engineering resources.

Visit to Foxtel

To research the base level of technology in the medium I spent some time at Foxtel, established on a wharf on the western harbour foreshore of Darling Harbour, adjacent to the temporary Sydney Casino — a fittingly appropriate neighbour, perhaps, considering Pay TV's high risk/high stakes history.

Foxtel's Director of Technology is Jim Blomfield, ex-Channel 9 Sydney,

who showed me around the impressive Pyrmont complex and later covered the operational ins and outs with welcome frankness.

Programming enters the building via three main ways: via optical fibre from TOC (Telstra Operational Centre), in nearby Kent Street; via another fibre which brings four of the eight Galaxy signals to Foxtel; and finally from the satellite dishes adorning the wharf's roof.

Explains Blomfield: "TOC gives us Sky News Australia; they run on coax between Frenchs Forest and TOC in Kent Street, and then across here as fibre. We also have tape (PAL Digital Betacam) coming into the building — mostly movie content and series. We can handle a lot of other formats as well, converting everything to Digital Betacam. Playout is mostly from Digital Betacam or cache disks."

Foxtel worked with Sony to develop a new transmission system using RAID 3 hard disks for the short form material — such as promos, community service announcements and later on, commercials. Each of the channels works with 2.5-hour caches to accept input material. "Some material", Blomfield added, "comes straight in and goes straight out."

Then there are signals coming in on the satellite dishes, looking at PAS2 or Intelsat: "We're dragging eight signals in from the satellites. CNN comes in from Asia; it originates obviously in the States, goes to Asia and is converted there — so some of the signals take a relatively long path to get here. It arrives here as PAL. Others come in as NTSC, which we convert to PAL."

Blomfield adds: "Once we get the material over to formats (digital) that we use, we then output to Telstra in a couple of ways. The signal goes into the compression equipment, via the encoders/mulitiplexers positioned here at Pyrmont."

The entry foyer of Foxtel's headquarters, situated on a wharf at Pyrmont, near Sydney's Darling Harbour.
Facing page: The current 'analog' home set-top decoder and card provided for Foxtel subscribers. The plan is for digital set-tops to replace these when volume production lowers the price.

"Once it has gone through the multiplexer, we then feed into the fibre optic network. And we hand that on to Telstra by fibre out of Pyrmont. There is diversity in the fibre — if all that fails, we're on a 40M bit microwave link to Kent Street as well — full 34M bit pipes running to Sydney, Melbourne, Brisbane, Gold Coast and soon Adelaide and Perth."

Foxtel's total package into the home today is 26 channels, of which 20 exit from Pyrmont. Another five are FTAs, which are injected at the head ends, and the last one is the automated weather channel, which is created at the head end. Soon it is expected the operator will add another five to the list.

A common model?

Was this form of collation and output common to the Pay industry elsewhere?

"Not really", said Blomfield. "I suppose Foxtel now would be becoming one of the largest in the world by sheer volume. If you look at the States there is an enormous number of channels, but they're all put together as individual channels and then sold to consortia or cable operators who bundle them up."

"We differ in that we will be offering a service to four million homes. So noone has a network as large geographically as we have, serving all capital cities — there's not really a model anywhere in the world. We are more like broadcasters."

"BSkyB (UK) is a little similar to this, but use a different delivery (satellite) mechanism. With theirs, they just throw one set of signals up and deliver to many. We are distributing all of the programming on cable."

No material arrives at Foxtel in MPEG 2, but everything is going out in MPEG2 DVB, which is emerging as the world standard. The signals are only converted to analog at the Telstra headends, where they're also modulated on the RF carriers.

Digital set-tops

As to when subscribers will be given digital set-top boxes, Blomfield answered that "it just comes down to the economies of scale on the digital set-top box. Although they are becoming reasonable, they are still too high in cost to make this business perform the way we

A digital editing suite at Foxtel. Once material has arrived in the Pyrmont facility, programming is handled in digital format.

need to become digital."

Was the audience aware that its subscription programming goes through compression?

Replies Blomfield: "No. In fact we originally had to start distributing in analog over a 40 megabit system, and when we turned MPEG on we didn't get one phone call, not even from engineers. Mind you we run a very good race. There are some operators running down around the 2Mb rate and under. We're not doing that. We don't need to, and don't intend to. We're extremely pleased with the quality, particularly with the compression equipment.

"We're not pushing the limits. There is a point where you have to pull back. We're nowhere near the limits that we could take it down to. But I don't suggest that we're going to start crunching."

Sport is something else, though. This writer did manage to dig up some viewer concern regarding visible compression artefacts on sporting coverage.

Blomfield: "You have to think about the trip that sports makes. It could start out somewhere in North America and go through any number of transmission chains, compression types and standards. By the time it finishes its trip, boy! It's been through a whole series of processes."

"Interestingly, large blocks of the colours green and blue undergo degradation in low bit rate compression — which is most unfortunate for sport. So if you're going through fast action and then you stop at a point, you may see some degradation of large chunks of the playing field. But it wouldn't be prudent to run anything in the sports area under 6M bits."

A Foxtel presentation suite. The equipment is all digital, and generally capable of very high quality.

"Our MPEG material is not really degrading anything. I mean we're running 6-8 megabits. It's pretty hard to pick artefacts at that rate."

"I think probably the best thing to judge the performance of MPEG by would be comparing live local content within the Foxtel channels. That will give you a true test, because it has originated in pure digital cameras running through a digital transmission system and front ending straight into the MPEG."

"But if you're looking at things like Discovery — well, that starts its trip somewhere in Denver, goes up in MPEG 1, comes down in Asia, is decompressed there, converted out of NTSC into PAL, goes up again in analog and down here. So it's taken a long trip."

"We're doing a lot of work with the suppliers to encourage and help them to see why quality is such an issue."

"Any material that is generated here should be superior to FTA, because few stations have become fully digital. It's not a slight on FTAs, but we are less than a year old — they're 40 years old. Our output today is looking spectacular because it is on all brand new equipment."

How about movies?

"Often the movie copy that we get will go on to the FTA users. They'd be getting the same digital transfer that we get. It just comes down to what you do with that material once you receive it."

"In an analog environment, if an FTA operator is using analog they could go a couple of generations, whereas everything we do is probably going the same two generations — but in digital."

"Being compressed data, the audio can be configured to suit operational needs. A great percentage of Foxtel's content arrives in stereo and goes out on the cable in stereo to the set-top box, which has a stereo (RF) output. The next set-top the company plans to introduce at the end of 1996 will have a stereo output, in the form of RCA terminals. Any movies that carry surround encoding will pass the information to the home receiver.

The Optus approach

Optus technical spokesman Murray Edwards stressed how carefully his team handle incoming and outgoing programming. Little arrives in MPEG 1; some is on Digital Betacam or analog

A studio at Foxtel. A useful comparison for viewers checking quality is to view live programming input from Pyrmont — which is carried as a completely digital signal, from camera to head end.

Another view of Foxtel premises and rooftop dishes, at Pyrmont's Wharf 8.

comments about compression artefacts in sports programming. He replied: "Of course, I'm hypersensitive. It's my job to notice artefacts. And I do notice things. But it's hard to pick where the artefacts have been generated — whether it's us, or someone else, or even a poor camera. Sports has the minimum compression — it has the most movement."

The Galaxy set-top box has stereo L and R audio outputs via RCA connectors, as well as a mono output, and reproduces any surround decoding a movie may have. The operator does not offer FTA station signals on its service. ❖

SP Betacam. Internally, JPEG compression is used for short term archiving, but at a bit rate which maintains quality.

Feature movies arrive at the company in PAL Digital Betacam form; sports programming arrives via the Optus dishes as an analog NTSC signal, which is converted within Optus.

Edwards feels MPEG 2 is still a little 'ropey' for Australian use.

The final output signal is sent to the headends around the country in digital form, then is disseminated as an analog signal to subscribers.

And Galaxy?

With Galaxy, the situation is a little more complex. This operator runs Digital Betacam in its Pyrmont complex, but of course has little control of the input, which may have travelled through an NTSC/PAL standards conversion more than once. Their much-vaunted movie programming arrives on Digital Betacam tapes. Much of their material arrives via satellite, in 'MPEG 1-1/2' and MPEG 2.

The output services three streams:

1. A fibre-optic link to the Centrepoint tower in Sydney, which then transmits a microwave signal (uncompressed) to the home.
2. A fibre-optic link to the Optus satellite centre, for direct-to-the-home satellite reception. This signal is compressed in MPEG 2.
3. An uncompressed signal path via fibre-optic link to Foxtel, which takes four channels of Galaxy's programming. This material is eventually compressed via MPEG 2 by Foxtel.

Galaxy also outputs two ethnic channels (Chinese and Italian). These are run from a bank of Panasonic S-VHS machines.

I asked Stephen Joyce, in charge of digital encryption at Galaxy, for his

Pay TV: Comments found on the Net

To elicit some responses from the viewing and paying public, a few Internet discussion groups were checked out to test the heat of the topic. Some of the comments:

'I was previously hooked up to Galaxy MDS (microwave). Living far from the city the picture was poor, yet I stuck with it... For anyone who has a stereo TV system, I gotta say the MDS decoders are crap. They only have an RF output, and in stereo the sound hisses and is out of balance.

I'm very happy with the picture on Foxtel. The picture is great most of the time, except when a lot of things move on the screen the picture gets a bit 'blocky'... maybe more video compression is used on those channels; (it's) especially noticeable on CNBC.'

'Telstra is probably wishing it started VisonStream above ground as well. From reports I've heard, considerable damage has been done to existing cabling when the new TV cable is being pulled down their ducts. The fault rate has increased considerably.'

'Perhaps it is 'time pressures' on the cable haulers, but it still appears that they just don't care enough to avoid rubbing right through one cable with another (just bung it in and that's it).'

From a pro photographer:

'I have (as of Friday) installed Optus on my two TV home sets. Am delighted with the quality of the pictures! Even my very old TV now has much sharper pictures then ever before — even on the commercial channels. In fact, even when the Optus box is turned off I get better than ever reception on my commercial channels. (No more need for inside aerials).'

Regarding Optus Vision:

'One problem is that the set-top box is not very reliable, in my experience. My (first) decoder failed and died only one day after it was installed. The technician said the quality control on the decoder is not all that great. One thing that I don't like about the current decoder is that they have no stereo RCA output. The video and left and right channel is modulated through the RF output. This is not a very flexible arrangement...'

And on the programming:

'There must be some B-grade production unit somewhere in the backblocks of Hollywood churning out scores of cable-ready crap...'

'What's the celluloid equivalent of 'pulp'? It's called telemovies.'

'In case anyone is contemplating a Galaxy connection, consider my appraisal. Programmes are punctuated every 15 minutes or so by self promotion and adds for other shows. This is the problem with buying shows where commercial breaks are written into the scripts. No ads mean big problems for the cable channels...'

A matter of bit rate

These days the challenge, in video transmission, is to handle the data stream. Consider the following:

A digitised standard PAL video signal requires a bit rate of 216Mb/s (megabits per second). Using MPEG compression, broadcast NTSC quality can be approximated at a rate of about 3Mb/s, and PAL quality at about 4Mb/s. Sports sequences with complex spatial-temporal activity need more like 5 - 6Mb/s.

CLOSE ENCOUNTER OF A 'MIR' KIND

In late March this year, NASA's space shuttle Atlantis made an in-orbit rendezvous and docked with Russia's Mir space station — bringing supplies and replacement parts, and also leaving US astronaut Shannon W. Lucid to spend some months on Mir. The exercise was very successful, and gave both the USA and Russia valuable experience in preparing for construction of the planned International Space Station.

by KATE DOOLAN

During July 1975, the world watched in fascination as spacecraft of the two traditional Cold War enemies — the United States of America and the Union of Soviet Socialist Republics — linked up in Earth orbit.

The Apollo-Soyuz Test Project (ASTP) was heralded as the beginning of a new age in international space cooperation, but political realities back on Earth made any form of high level cooperation virtually impossible until relatively recently.

In late June 1995, a new age of space cooperation began when the US space shuttle Atlantis on flight STS 71 docked with the Russian space station Mir, in the first of a series of 10 flights that will be taking place over the next two years. Since then, STS 74 and STS 76 have docked with Mir. The last flight, that of STS 76, left American astronaut Dr Shannon Lucid onboard Mir whilst her American colleagues returned to Earth.

Unlike the ill-fated ASTP program, the current cooperation between the two former Cold War enemies will be an ongoing project which may one day culminate in a planned joint flight to the planet Mars.

Before Mars will come the much maligned International Space Station, which is unofficially known as 'Alpha'. This will be the preeminent and permanent orbiting scientific laboratory. Alpha is being developed and assembled in three phases, each of which is designed to maximise joint space experience and permit early realisation and return on a large joint investment that will involve 15 countries. The countries that are involved with Alpha include the

United States, Russia, Canada, Japan and the countries of the European Space Agency (ESA).

During the first phase (Phase I), the United States and Russia will work together on the space shuttle and Mir. They will conduct joint Extra Vehicular Activities (EVA or 'space-walks') and practice space station assembly techniques by adding new modules to Mir. American astronauts will also live onboard Mir alongside Russian cosmonauts, to gain long-duration space experience.

Space Station Phase I

International Space Station Phase I began in February 1994 when Russian cosmonaut Sergei Krikalev flew aboard the space shuttle Discovery as part of the STS 60 crew. In February 1995, during the STS 63 flight (see *EA* August 95), cosmonaut Vladimir Titov was onboard Discovery as it flew to within 10 metres of Mir in rehearsal for the flight of STS 71.

On 14 March 1995, American astronaut Dr Norm Thagard was launched into space by a Russian Soyuz rocket and flew to Mir for a three-month stay with two Russian cosmonauts. Following a successful program of scientific experiments and medical testing, Thagard and his crewmates were returned to Earth aboard the space shuttle Atlantis in July 1995, after Atlantis and the crew of STS 71 successfully docked with Mir for the first time.

The purpose of Phase I is to lay the groundwork for the International Space Station Phases II and III. Phase II will begin in 1997, when a core space station module containing a US laboratory module will be placed in orbit. The US laboratory will be operational during the 'Utilisation' flights beginning in 1999 with Phase III, whilst assembly of the space station continues.

Phase III will end in 2002 when assembly is complete. By then, astronauts and cosmonauts from each of the countries building the station will be working on a full time basis.

Phase I will contribute to the success of Phases II and III in four major areas:

- Americans and Russians working together on Earth and in space practicing for the future International Space Station.
- Integration of US and Russian hardware, systems and scientific aims over a long period of time.
- Risk reduction-mitigation of potential surprises in operations, spacecraft environment, spacewalks and hardware exchange.
- Early initiation of science and technology research.

Unlike the American space program, the Russian space program has been interested in long duration spaceflight since the late 1960s. In 1971, the then Soviet Union launched the Salyut 1 space station and until 1986, a series of Salyut space stations were occupied on a continual basis.

Salyut 6 success

Salyut 6, launched on 29 September 1977, was heralded as a great advancement for the Soviet space program as it was capable of more complex missions as well as longer stays in space. Used from 1977 until 1981, Salyut 6 carried several large pieces of experimental equipment that were installed prior to launch. The space station also played host to a large number of experiments bought aboard by the unmanned Progress supply missions and manned Soyuz spacecraft. The capabilities of Salyut 6 allowed new records to be set in human space endurance, with cosmonauts staying aboard for up to six months at a time.

Launched on 19 April 1982, Salyut 7 was seen as a disappointment by western space observers as no great technical advances were made over the previous station. Although the onboard equipment was improved, the actual station itself was almost identical to Salyut 6. The Soviets never planned to have a continuous human presence on Salyut 7, but it was designed for longer duration missions. The failure of crew health prevented cosmonauts from setting longer duration records.

In 1986, continuous crew operations onboard Salyut 7 ceased and the emphasis in the Soviet space program turned to the new Mir complex. Cosmonauts returned to Salyut 7 in May 1986 to salvage anything that they could for Mir. In October 1986, Salyut 7 was boosted to an altitude of 480km and left unoccupied, monitored only by mission control. In 1989, telemetry from the station ceased and on 7 February 1991, Salyut 7 reentered the Earth's atmosphere over Argentina, where large pieces of the

A view of the space shuttle Atlantis, taken by one of the two cosmonauts on Mir-21 before the two docked. Visible in the shuttle's cargo bay is the Spacehab module (lower centre), and also the docking system (upper centre). On the facing page is the Mir space station, as seen from the approaching Atlantis.

spacecraft were eventually recovered.

About Mir

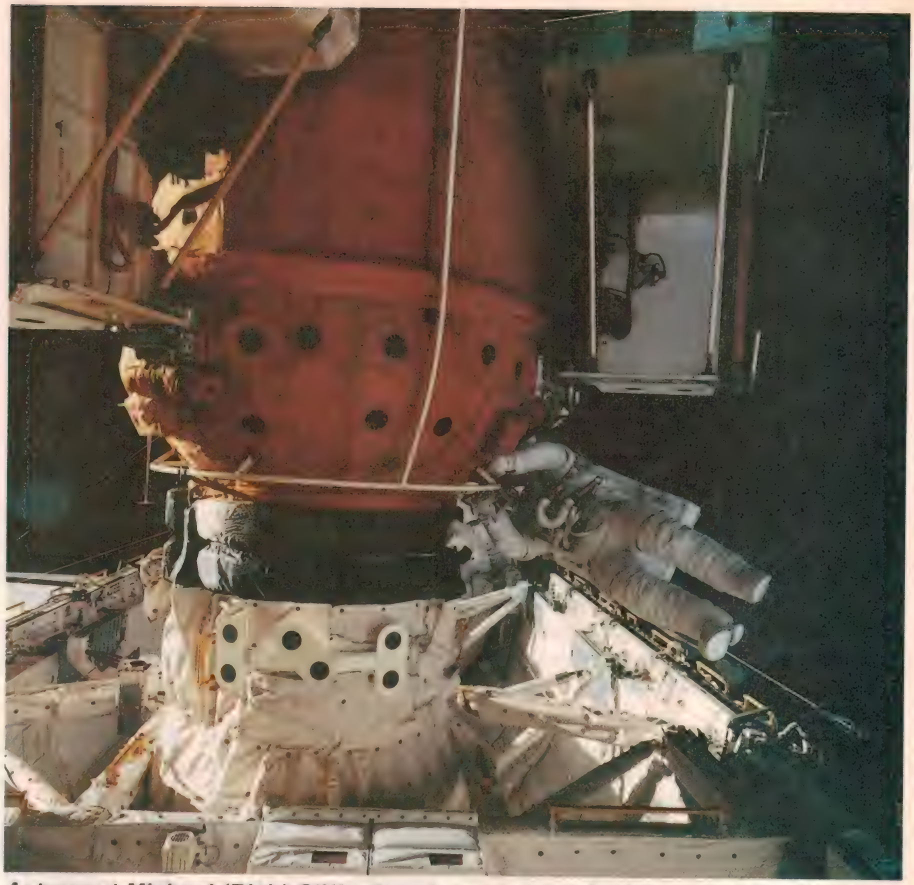
The Mir complex ('mir' is the Russian word for 'peace' or 'world') was described by its Soviet designers as being their third generation space station. Launched on 20 February 1986, Mir is the central portion of the Mir complex and supports the design concept of a Mir complex as an assembly of separate pressurised modules with both core and speciality functions.

The Core Module is the control centre for the entire space station and also contains working and living areas. The major habitable volume is made from concentric cylinders measuring 13.2 metres in length and with a diameter of 4.1m. The working area houses not only the control centre but also a pilot's station and medical monitoring equipment. The living area has individual crew cabins, a galley and a personal hygiene compartment which contains a toilet, sink and shower.

The Core Module has two axial docking ports — fore and aft — for Soyuz-TM human transports and automated Progress-M supply ships, plus four radial ports for expansion modules.

To date the Russians have added four expansion modules to the Mir core:

- Kvant, which is berthed at the Core Module's aft axial port. This module was launched on 31 March 1987 and contains a series of international astrophysics experiments.
- Kvant 2, launched on 26 November 1989, which is docked at a radial port. This was the first of a series of specialised scientific modules that were to make up the Mir complex. An important feature that Kvant 2 added was an airlock that made Extravehicular Activities (EVA) easier to perform.
- Kristall, which was berthed opposite Kvant 2. This was launched on 01 June 1990. It carried two stowable solar arrays, science and technology equipment plus a docking port equipped with a special androgynous docking mechanism designed to receive heavy spacecraft equipped with the same sort of docking unit. The androgynous unit was originally designed for the Soviet space shuttle Buran, which made its one and only flight in 1988.
- Another module, Spektr, carrying American equipment. This was added to the Mir complex during 1995 as part of the International Space Station Phase I program.



Astronaut Michael (Rich) Clifford works on a restraint bar on the docking module of Russia's Mir space station (orange), while Atlantis was docked with it. The shuttle's docking system (white) and the cargo bay are visible at the bottom of the picture.

Spektr was launched from the Baikonnur Cosmodrome in Kazakhstan on 20 May 1995, and was berthed at the radial port opposite Kvant 2 after Kristall was moved out of the way during a spacewalk by cosmonauts Vladimir Dezhurov and Gennady Strekalov, in preparation for the first docking with the American space shuttle Atlantis. Spektr carries four solar arrays and scientific equipment belonging to both American and Russian space programs.

Docking module

A Docking Module (DM) was delivered to Mir in November 1995 by the US space shuttle Atlantis and the crew of STS 74. The Russian built Docking Module was then attached to the Kristall module.

Without the Docking Module, Kristall must be moved to Mir's longitudinal axis to provide clearance for each space shuttle docking. The longitudinal axis location is temporary for Kristall because that port is normally used by Progress resupply vehicles and Soyuz spacecraft. It is also inconvenient to move Kristall from port to port in preparation for each space shuttle docking.

The DM allows clearance for the space shuttle to dock with Kristall at the radial axis of Mir. Kristall will not be removed and all space shuttle dockings will in future use the DM which also may be used for future Soyuz dockings.

The Docking Module is 4.5 metres long from tip to tip, has a diameter of 2.1m and weighs 4087 kilograms. It is constructed of aluminium alloy, covered on the exterior by Screen Vacuum Thermal Insulation and a micrometeroid shield. A truss structure is attached to the module to provide latching to the space shuttle whilst horizontal in the shuttle's payload bay.

On the exterior of the DM, two solar array panels were attached to transport solar arrays to Mir. The solar array containers are attached on either side of the top of the module to provide clearance whilst in the space shuttle's payload bay. The solar arrays were removed from their containers and attached to Mir during a spacewalk by cosmonauts.

The two solar arrays are different types. One is called the Cooperative

Solar Array (CSA), and was built as a cooperative effort between NASA's Lewis Research Centre and the Russian Space Agency. The CSA uses Russian structures and NASA photovoltaic modules and was designed as part of the Phase I operations of the International Space Station Program. The CSA is expected to provide greater power and longer life expectancy over existing arrays and will also help to power US experiments aboard Mir. The second solar array is a Russian designed and produced by the Russian Space Agency.

A grapple fixture is also attached to the topside exterior of the Docking Module for use with the space shuttle's Remote Manipulator System (RMS) arm, used to unberth the DM from the payload bay. Also attached to the exterior of the DM are several hand holds for use during extravehicular activity. An external camera is mounted to the DM for use as a backup if the interior centreline camera fails.

A Remotely Operated Electrical Umbilical (ROEU) supplied space shuttle power to the Docking Module whilst it was mounted horizontally in the payload bay. This allowed theDocking Module's avionics systems to continue receiving power and telemetry, in preparation for the Mir docking.

The DM is pressurised at all times during the ascent phase and unberthing from the payload bay. Telemetry information is supplied to the space shuttle's crew on pressure, temperature, fan operations and docking equipment status. The crew can also control docking mechanisms, valves, fans, closed circuit television and other equipment.

Power supply, commanding and telemetry for the Docking Module were switched from the space shuttle to Mir after the space shuttle had docked.

Final module

Mir was finally completed on 20 February 1996 when the Priroda module was launched into space aboard a Proton launch vehicle. Priroda is berthed at the radial port opposite Kristall and carries microgravity and Earth observation equipment including one tonne of American equipment.

Once Priroda was added to Mir, the complex weighed over one hundred tonnes. Mir is now made up of seven modules launched separately since 1986 and the experience gained by the Russian space program will be invaluable for both the International Space Station Alpha program and any future long term space flights.

STS 76 team

Following the successful completion of STS 74, the space shuttle Atlantis was towed to the Orbiter Processing Facility at the Kennedy Space Centre in Florida during November 1995. Following refurbishment, Atlantis was towed to the Vehicle Assembly Building where it was mated to the External Tank and Solid Rocket Boosters stack before being moved to Pad 39B on 28 February 1996. The Spacehab module was added to Atlantis the following day.

Cosmonaut Yuriy Onufriyenko gives a 'thumbs up' sign to indicate successful docking of Atlantis and Mir, while visiting in the Atlantis flight deck with STS-76 mission commander Kevin Chilton (right).

The highly experienced crew of STS 76 was commanded by Kevin ('Chilli') Chilton, who was making his third space shuttle flight. Pilot Rick Searfoss was making his second spaceflight, as was Payload Commander Ron Sega who had previously spent time in Russia as NASA's Operations Director, overseeing training for the American astronauts training for flights on Mir. Mission Specialists Rich Clifford and Linda Godwin were making their third space flights.

Astronaut Shannon Lucid, who was to remain on Mir after the Atlantis returned to Earth, would become the first woman to make five spaceflights. Lucid had been named to the STS 76 crew in November 1994 and had been training with her backup astronaut John Blaha at the Star City Cosmonaut Training Centre outside Moscow in Russia since February 1995.

Launch delayed

The launch of Atlantis was delayed for 24 hours because of high altitude winds, but all went well with the launch on 22 March at 3:13 am (local time) lighting up the night sky around the Kennedy Space Centre for hundreds of kilometres.

Immediately after launch Atlantis started to play catchup with Mir, which was then over Tasmania — some 10,000 kilometres away. As the space shuttle climbed towards orbit, a leak in one of Atlantis' auxiliary power units (APU) raised concerns that the flight may not have run its full course and the docking with Mir would have possibly-to be cancelled.

Mission controllers noticed a pressure loss in the third APU, which operates the steering mechanisms of the ascent and descent phase of the space shuttle's flight. About a quarter of the oily, red hydraulic fuel had leaked out. After an initial assessment, Mission Control assured the crew that they could proceed with plans for the docking with Mir.

For STS 76 to dock with Mir, the whole procedure began with the carefully timed launch window of only six to ten minutes, to put Atlantis on course with the space station. Over the next two days, periodic small engine firings bought Atlantis to a point 12 kilometres behind Mir. At that time, the Terminal Phase Initiation (TPI) burn was fired and the final rendezvous phase began.

As Atlantis moved towards Mir, its rendezvous radar system began to track the space station to provide range and closing rate information to the STS 76 crew. As Atlantis moved closer towards

Close Encounter...

Mir, the Trajectory Control Sensor (a laser ranging device mounted in the payload bay) supplemented the shuttle's onboard navigation information by supplying additional data on range and closing rates towards Mir. The crew also began air-to-air communication with the Mir 21 crew of Yuri Onufrienko and Yuri Usachev.

Unlike most space shuttle rendezvous procedures, Atlantis aimed for a point directly below Mir, along the Earth radius vector (R-Bar) which is an imaginary line drawn between the Mir centre of gravity and the centre of the Earth. Approaching along the R-Bar from directly underneath Mir allowed natural forces to brake Atlantis' approach, more than would occur along a standard space shuttle approach from directly in front of Mir. During this approach, the STS 76 crew used a handheld laser device to supplement distance and closing rate measurements made by Atlantis' navigational equipment.

The manual phase of the rendezvous began when Atlantis reached a point about 1km below Mir. Commander Chilton flew the space shuttle using the aft flight deck controls as Atlantis began to move closer to Mir. During the approach up the R-Bar, Chilton performed a 180° yaw rotation to align Atlantis with Mir.

Because of the 'R-Bar approach', Chilton had to perform several brake firings. These firings when required meant that Atlantis' jets were used in a mode known as 'Low Z', a technique that uses slightly offset jets on Atlantis' nose and tail to slow the spacecraft rather than firing the jets directly at Mir. This technique avoids contamination of Mir and its solar arrays by exhaust from the space shuttle's steering jets.

Using the centreline camera fixed on the centre of Atlantis' docking mechanism, Chilton centred Atlantis' docking mechanism with the Docking Module on Mir, continually refining the alignment as he approached to within 100 metres of Mir.

At a distance of 10 metres, Chilton 'station kept' momentarily to adjust the docking mechanism. The STS 76 crew used ship-to-ship communications with the Mir to inform the two cosmonauts of Atlantis' status and kept them informed of major events including confirmation of contact, capture and the conclusion of 'damping' — the halting of any relative motion between the two spacecraft after docking. This is performed by shock-absorber type springs within the docking device.

Once Atlantis was docked with Mir, commander Kevin Chilton floated through the Docking Module to Mir where he shook hands and hugged his Russian counterpart Yuri Onufrienko. Following that, the Russian cosmonauts were presented with chocolate Easter bunnies, flowers and other presents from the STS 76 crew.

Following a celebratory meal inside Mir, the STS 76 crew began to shift some 2.1 tonnes of supplies to Mir — including food, water, scientific equipment plus those supplies needed by Shannon Lucid for her stay on Mir.

Spacehab module

Like other Space Shuttle-Mir flights, Atlantis carried a Spacehab module onboard. Over the course of the docking flights, Spacehab will carry a mix of supplies and scientific equipment to and from Mir.

On STS 76, the Spacehab module was in a single module configuration similar to previous Spacehab flights. In addition to the Spacehab short tunnel and airlock which had flown on previous Spacehab missions, there was an extended tunnel beyond the airlock and a 350mm tunnel extension built by Spacehab Inc., to position the Spacehab module in the optimal part of Atlantis' payload bay. Because the single module was positioned further aft than on previous flights, the space shuttle was able to carry additional cargo up to Mir.

A double rack aboard Spacehab was dedicated to some of the Russian logistical equipment, including a gyrodyne and the Individual Equipment and Seat Liner (IESL) kit. The gyrodyne was transferred by the STS 76 to replace a used one. The IESL kit was also transferred to Mir, to be available for use by Shannon Lucid should she have to make an emergency return to Earth aboard a Soyuz spacecraft.

On flight day six, Linda Godwin and Rich Clifford performed a six hour EVA to install the Mir Environmental Effects Payload (MEEP) on the exterior of Mir's docking module and to evaluate new EVA equipment. The spacewalk was the first to be performed by American astronauts on a space station since Skylab in 1974 and the spacewalk performed by Godwin and Clifford was the first performed from the docked space shuttle and Mir complex.

The Simplified Aid For EVA Rescue (SAFER) unit, first used in September 1994 aboard STS 64, was worn by Godwin and Clifford and was to be used for emergency purposes only. It was designed for self-rescue by an astronaut in the event that the space shuttle is docked to Mir and unable to retrieve a detached, drifting astronaut.

Whilst Godwin and Clifford were working in the payload bay, Ron Sega served as coordinator of tasks from inside Atlantis' crew cabin. Prior to beginning the EVA, the hatches of both Atlantis and Mir were closed at the docking mechanism. A hatch at the end of the shuttle tunnel adaptor was also closed, allowing only the airlock and tunnel to be depressurised. All of the

Visiting STS-76 crew members enjoy Russian food in the base block module of the Mir Space Station. Left to right are astronauts Shannon Lucid, Linda Godwin, Michael Clifford, Richard Searfoss and commander Kevin Chilton. Lucid was in the process of transferring from STS-76 to Mir-21, where she would stay for some months as a guest researcher.

STS 76 crew (besides Godwin and Clifford) were in the Atlantis' crew cabin for the duration of the spacewalk, whilst the Mir-21 crew including Shannon Lucid were aboard Mir.

The Mir Environmental Effects Payload (MEEP) consisted of four experiments which are going to be left on the exterior of Mir for 18 months before being retrieved by a future space shuttle crew. The data from these will help characterise the space environment at a 51.6° inclination, which is the same inclination at which the International Space Station Alpha will be located.

The Polished Plate Micrometeroid Debris experiment will expose metal plates in the Mir orbital environment, in order to identify characteristics of meteoroid and debris impact sites. The Orbital Debris Collector will capture hypervelocity particles to characterise their residues, while the Passive Optical Samples I and II experiment will be used to assess the magnitude of particulate and molecular contamination on materials exposed to the Mir environment.

Godwin and Clifford also evaluated common US/Russian EVA tools and safety tethers with larger hooks to allow attachment to Mir's exterior handrails, as well as installing a new foot restraint designed to allow detachment to Mir fixtures. Finally, the two astronauts removed the Docking Module television camera — using cable cutters to sever the cable connecting the camera, and then turning a knob to release the camera mounting. The camera was tethered and returned to Atlantis with the two astronauts once their EVA was complete.

Undocking day

Flight day eight saw the Atlantis ready to undock from Mir. Following an emotional farewell ceremony that included bear hugs and tears, the initial separation was performed by springs that gently pushed the space shuttle away from the Docking Module. Both Atlantis and Mir were in a mode known as 'free drift' during the undocking. This was a mode that cut off the steering jets of each spacecraft, to prevent inadvertent firings.

Once the docking mechanism springs pushed Atlantis away to a distance of 600mm from Mir, Kevin Chilton turned the space shuttle's steering jets back on. The jets were fired in the Low-Z mode so that Atlantis began moving slowly away from Mir, without contamination.

Atlantis continued to fly away from Mir to a distance of 180 metres, when Rick Searfoss began a 'fly around' of the station. At that distance, Atlantis circled Mir twice before firing its jets to move away from the station.

Following a well deserved rest, the remaining STS 76 crew began a series of experiments aimed at students. One was the Shuttle Amateur Radio Experiment II (SAREX 2) which had been used on previous flights. The second, more intriguing experiment was the Youth Enhancing Space Project or 'KidSat', which is a three-year pilot program that will fly on the shuttle on a yearly basis. KidSat aims to give high school students the opportunity to participate in space exploration.

KidSat enables students to configure their own payload of a digital video and camera for flight on the space shuttle, and to command the camera from their classrooms, downloading their images to Earth in near real time.

For STS 76, the payload included a Kodak DC460C digital camera mounted on the Atlantis' overhead window and a video camera mounted in the payload bay, to monitor the Earth along the space shuttle's flight path. Orbiting communication satellites and the Internet transmit commands, telemetry and image data back to Earth based classrooms. The images will be used as the basis for a variety of classroom discoveries including history, geography, geology, physics,

On the aft flight deck of Atlantis, astronaut Linda Godwin uses a handheld laser rangefinder to check the distance of Mir, during the docking operation.

mathematics, oceanography and current events.

Images can be viewed on the World Wide Web site: **http://www.jpl.nasa.gov/kidsat**.

For two days, cloudy skies over Florida prevented Atlantis from landing at the Kennedy Space Centre. There was one problem that almost caused the space shuttle to make an emergency landing, when two switches indicated that the payload bay doors that must be opened during orbit had not swung open. The doors must be open to dispel heat from electronic equipment, and are only closed for landing.

After making a visual check to confirm the latches were open, the STS 76 crew had been ordered to override the automatic system and manually open the doors.

Early in the morning of 31 March 1996, the Atlantis made a perfect touchdown at the Edwards Air Force Base in California after a journey of 6.1 million kilometres. Shannon Lucid was remaining on Mir until August or even later, due to recent problems with the Solid Rocket Booster ROS rings on STS 78 during July 1996.

The STS 76 mission and its linkup with Mir clearly demonstrate that the future of spaceflight has finally arrived. It is now also apparent that cooperation between all major spacefaring nations is the only way to go.

In closing, the author wishes to thank Geoff Allshorn and Debbie Dodds of the Johnson Space Centre; Lisa Fowler of the Kennedy Space Centre; and Mary Hardin of the Jet Propulsion Laboratory for their assistance in the completion of this article. All photographs are reproduced by courtesy of NASA. ❖

NEW BOOKS

Op-amp design

OP AMPS: DESIGN, APPLICATION AND TROUBLESHOOTING, by David L. Terrell. Second edition, published by Butterworth-Heinemann, 1996. Soft covers, 255 x 180mm, 488 pages. ISBN 0-7506-9702-4. RRP $95.00.

Op-amps are essential building blocks of modern electronics, and inevitably there have been numerous books about them. However many are little more than 'cookbooks', with a large number of application circuits and little real explanation of their operation or how they're designed. At the other extreme are the high-end engineering texts, going very deeply into either the detailed design of the op-amps themselves, or specific and perhaps esoteric applications.

In contrast, this book seems to strike an excellent balance between basic theory and design practice. It seems to have been written as an undergraduate and technical college text, and provides a comprehensive and consistent mix of circuit theory, presentation of all major op-amp circuit applications, design procedures (with worked examples), practical circuit analysis and measurements, and even device data at the end. The end result is particularly satisfying, and should make the book of value not only to students but to almost anyone needing a sound introduction to and reference on, op-amps.

It probably won't appeal to those who simply want an op-amp circuit cookbook, with everything worked out and very little explained. But if you want to understand the 'nitty gritty' of how op-amps are really put to work, it would make an excellent reference and guide. Warmly recommended.

The review copy came from Butterworth-Heinemann Australia, of PO Box 146, Port Melbourne 3207. (J.R.)

NiCad batteries

ALL ABOUT NICKEL CADMIUM BATTERIES, by T.R. Mishra. Published by BPB Publications, 1994. Soft covers, 180 x 235mm, 308 pages. ISBN 81-7029-414-2. RRP $22.95.

You might think it would be difficult to fill 308 pages with information about NiCad batteries. But this book, from the New Delhi publisher BPB Publications, does just that.

The bulk of the book is about NiCad charger circuits, but predictably, the author discusses NiCad cells in considerable detail in the first chapter, comparing them to other types of cells. Chapter 2 describes simple charger circuits, and constant current sources are presented in the next two chapters. Chapter 5 describes 41 practical NiCad battery charging circuits. Each is explained in detail and a circuit diagram, parts list, and even a wiring diagram for tag strip mounting is included. It's this chapter that will appeal to many hobbyists.

Fast charging techniques are explained in the next chapter, and again practical charger circuits are given, but without construction details. Most of these circuits rely on sensing the temperature increase exhibited by a NiCad when it approaches full charge. To this end, the author presents the design and construction of various temperature probes.

Maintaining and restoring a NiCad cell is discussed in Chapter 7. The remaining chapters present commercial circuits, including eight charger circuits available (in India) in kit form (includes a PCB pattern) and, as the author calls them, five 'add-on' circuits.

The technical level will suit hobbyists with some experience, and professionals. The review copy came from Jaycar Electronics, and the book is available from your nearest Jaycar store, catalog number BM2485. (P.P.)

Camcorder servicing

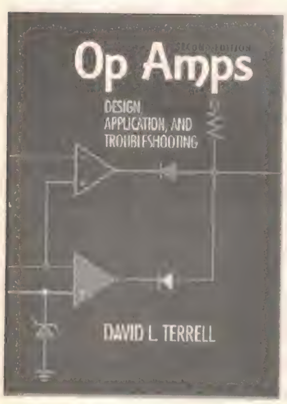
TROUBLESHOOTING & REPAIRING CAMCORDERS, by Homer L. Davidson. Second edition, published by McGraw-Hill 1996. Soft covers, 235 x 188mm, 525 pages. ISBN 0-07-015760-X. RRP $49.95.

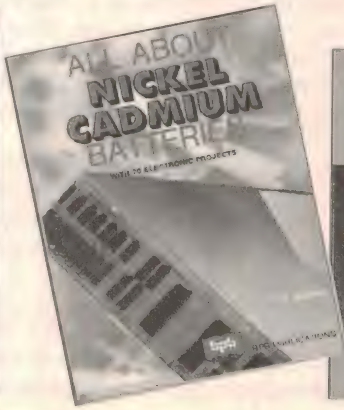
US author Homer Davidson's many books on various aspects of electronics servicing have become widely read, especially by those who need to service consumer equipment which is either made in the USA, or sold there as well as here in substantially similar models. This new second edition of his successful handbook on camcorder servicing should be equally popular, as it has been updated to include new technology such as fuzzy logic circuits and dynamic image stabilisation systems.

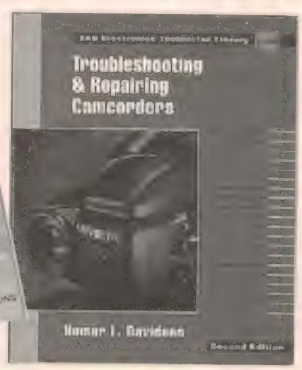
There are 14 chapters in all, and the coverage begins with introductory material on video formats, general servicing techniques and the operation of key sections in a camcorder: the camera section, video processing, system control, transport servos, motors and audio circuits, and mechanical considerations. Then follow chapters dealing with actual servicing and adjustment, of both the mechanical and electronics sections, and finally troubleshooting.

Inevitably the emphasis throughout is on US brands, models, video formats and the NTSC television system. I couldn't even find a mention of PAL, for example, even in the glossary at the back. However despite this I believe the book is still likely to make a worthwhile reference — especially for practising service technicians — because of its information on basic camcorder principles and construction, and discussion of the appropriate servicing techniques.

The review copy came from McGraw-Hill Australia, of 4 Barcoo Street, Roseville 2069. (J.R.) ❖







TRYING TO CATCH A GRAVITATIONAL WAVE...

Scientists at the Department of Physics in the University of Western Australia are playing a key role in international efforts to detect gravity waves — along with their colleagues in CSIRO's Division of Applied Physics, in Sydney. Here's a look at what's being achieved.

by GEOFF McNAMARA

When Heinrich Hertz proved the existence of electromagnetic waves in 1887, no one could have imagined the electronic revolution that was to follow. Along with every other aspect of society, this new spectrum of nature changed our view of the Universe dramatically and unexpectedly.

In the late twentieth century, we may again be on the verge of a perceptual revolution. Scientists are getting ready to open an entirely new window on the Universe. But this time it's not a spectrum of electromagnetism; this time it's the spectrum of gravity.

Every day experience suggests that gravity is simply that which keeps us from floating off the ground. Even thinking of the Moon orbiting the Earth or of planets orbiting the Sun can be visualised as a balance between an inward gravitational pull and outward centrifugal force. In 1917, however, Einstein defined gravity in a different way. His Theory of General Relativity describes gravity as the curvature of space caused by anything that has mass. When the Moon orbits the Earth, for example, it is simply following the local contours of space.

A common analogy used to explain the modern view of gravity is by thinking of space as a rubber sheet stretched taught. If you place a mass like a bowling ball onto the sheet it will create a depression. A marble rolled along the sheet — the marble itself causing its own small depression — will more than likely be 'attracted' to the bowling ball and head toward it. Depending on how fast you flicked the marble, it may simply move around the ball, end up in a brief orbit as it follows the contours of the depressed sheet, or it may be 'sucked in' and impact with the ball. Such is the nature of space: objects interact in the same way, by creating local and complex depressions in the curvature of space.

If space can be bent by the various things that inhabit it — stars, planets, galaxies — then it should be possible to create waves in space. In fact, this is one of the lesser-known predictions of General Relativity. Every time anything in the Universe accelerates, it creates waves in the fabric of space like the ripples left behind a boat sailing across a dead-calm sea. And just like the boat's wake, 'gravitational waves' should be detectable.

Listening, listening

The first attempt to search for gravitational waves was made by Joseph Weber at the University of Marylands in the US, back in the 1960s. Weber attached piezoelectric crystals to a large cylinder of aluminium. The idea was that if a gravitational wave should pass through the Earth the cylinder would change shape slightly, flexing the crystals and causing them to emit tiny currents that could be detected. Although Weber's experiment failed to detect gravitational waves, it showed scientists how to search for them.

One group that has taken up the challenge is led by Associate Professor David Blair, at the Department of Physics in the University of Western Australia. Blair points out that one of the reasons why Weber — and everyone else so far — has failed to detect gravitational waves is that space is so 'stiff'. This makes it difficult to create vibrations that are loud enough to 'hear'.

"Newton assumed that space was infinitely stiff", Professor Blair points out, "but we now know it's just very, very stiff!" In fact, if a boat were sitting in an ocean of cold, solid steel it would be a billion, billion, billion times easier to detect its wake than if it were in space.

However, the Universe is awash with powerful events energetic enough to substantially disturb the fabric of space: merging black holes, neutron star binaries, even supernovae. These rare but violent events *should* produce gravitational waves large enough to be detected on Earth, you'd think. But even the most violent processes produce incredibly weak gravitational waves.

To enable them to listen for these events, Blair's team has developed a gravitational wave detector of amazing sensitivity. The detector is based on Weber's original experiment. Rather than use an aluminium cylinder, however, Blair's team uses a three metre long, one and a half tonne cylinder of niobium — the largest piece in the world. The niobium bar is fitted with superconducting sensors far more sensitive than Weber's crystals.

"We've now invented an even more sensitive way of doing it", says Blair, "using sapphire resonators." The move to sapphire resonators will make the bar a thousand times more sensitive again. But how sensitive is that?

"Our detector is able to detect the impact of an oxygen atom dropped onto a table from a height of 30 centimetres", Blair explained. "This is the smallest energy level that anyone can conceive of measuring. It is, in fact, close to the limits of what quantum mechanics allows you to measure."

Faced with the incredible sensitivity of their detectors and the softness of the 'cosmic voice', gravitational wave researchers have to isolate their detectors from all terrestrial sources of vibration. For Blair and his colleagues, this includes the micro-seismic waves produced by sea waves crashing on the Western Australian coast. Sitting in a vacuum chamber and cooled to liquid helium temperatures, the niobium bar sits silently, waiting for the passage of gravitational waves.

Blair and his colleagues aren't sitting idly as they wait for the passage of a gravitational wave. While the niobium bar experiment is sensitive enough to detect the formation of a black hole ("...a rare event, but we've still got a better chance of detecting one than of winning the lottery!" Blair said), the team want to build a gravitational wave observatory based on laser optical interferometer technology.

An artist's impression of the planned Australian International Gravitational Observatory. (Courtesy Meredith Graphic Art and BHP Engineering.)

Laser interferometer

The design calls for mirrors to be placed at the ends of two long tunnels placed at right angles. A laser fired through a beam splitter will be reflected back and forth thousands of times by the two mirrors before being recombined. If the distance to the mirrors is exactly the same, then the two beams of light will be in phase, that is the peaks and troughs will match when they're recombined.

The mirrors also act as test masses which will respond to the passage of a gravitational wave. If and when a wave passes through the observatory, the distance between the mirrors will alter slightly. With different distances to travel, the light beams will be slightly out of phase with one another. When they're recombined, they'll produce a characteristic interference pattern.

There are three such observatories under construction in the northern hemisphere, employing tunnels kilometres long. If one observatory detects gravitational waves, the event should be confirmed by the other two observatories, eliminating spurious events.

But Blair points out that a fourth observatory in the southern hemisphere would create a three-dimensional global detector system. As well as increasing the sensitivity of the system by up to 50 times, the southern hemisphere detector would allow scientists to identify the direction of the incoming gravitational wave simply by looking at the relative arrival times at each observatory. And Blair has just the place in mind for a southern hemisphere gravitational wave observatory: the Wallingup Plain in Western Australia.

The Australian observatory would be a smaller version of the northern hemisphere counterparts, but would entail a number of unique improvements to enhance its sensitivity. One such improvement is a switch from using silica (glass) mirrors to using pure crystals of artificial sapphire.

"In the last year we've shown that by changing the test masses from silica to sapphire you can increase the sensitivity of the detectors by about 16 times in amplitude", said Blair. "That's the equivalent of being able to see about 4000 as many sources as you previously could."

Test mirrors have been produced by the CSIRO's Division of Applied Physics in Sydney. A team headed by Chris Walsh had to develop new surfacing techniques to polish the sapphire mirrors, and this has earned them a world-wide reputation.

"What sets these mirrors apart from precision telescope mirrors is they have to be extremely smooth across the entire surface", Walsh explained. While ripples can be tolerated on an ordinary telescope mirror, the way in which the sapphire mirrors will have to perform means they have to be, in effect, 'super mirrors'.

It's taken Walsh and his colleagues years to develop the techniques needed to polish sapphire mirrors. The main difficulty is that sapphire is much harder than glass, calling for a polishing process which removes material from the surface of the mirror very slowly and in a very controlled fashion.

Sapphire also behaves differently from glass when suspended. Glass sags under its own weight, changing the shape of the polished surface; sapphire does this to a lesser extent. While a mirror would seem perfectly flat when lying down, when suspended it changes shape. Walsh and his team have overcome these and other difficulties and claim they've created "a unique capability world-wide". In fact, the CSIRO

Trying to Catch a Gravitational Wave

The niobium bar gravity wave experiment at the University of Western Australia. Three metres long, the bar weighs 1.5 tonnes — the largest piece of niobium in the world. (Courtesy Assoc. Prof. David Blair, University of WA.)

opticians are on the short list for producing sapphire mirrors for the USA's gravitational wave observatory, LIGO.

To isolate the Western Australian mirrors from vibration, Blair's team will suspend them from pendulums. As anyone who has heard the stately pace of a grandfather clock will know, the longer the pendulum the slower the swing. It turns out that the longer the pendulum suspending a mirror, the better that mirror is protected from vibration.

"The quality of the isolation of the mirrors is set by the length of the pendulums that support them," Blair explained, but points out there's a practical limit to how long you can make a pendulum: "If you want to get down to frequencies that cut out almost all vibrations, the pendulums would have to be about a kilometre long! Well, that's quite an outrageous suggestion, especially when you have to suspend quite a few of these pendulums one below the other."

To get around the problem, the UWA team invented a 'folded pendulum'. The device sits 20cm high but behaves exactly the same as a kilometre-long pendulum. To reduce vibrations still further, pendulums have to be able to swing for a long time with no energy input. The pendulum design developed at UWA has such a low loss rate that once set swinging, it would continue keeping time for 300 years without a single push.

Research for the Australian gravitational wave observatory is well under way, made possible by a $1.5 million Australian Research Council grant — the largest ever made. The technology needed for the interferometer must be completed in 1996 before funding will be granted for the construction of the interferometer itself.

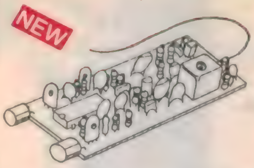
Following the discovery of radio waves, it was decades before useful astronomical discoveries were made. There are now no doubts at all that gravitational waves exist. In fact, the 1993 Nobel Prize in physics was awarded to Joe Taylor and Russel Hulse for their work on a binary pulsar exhibiting the effects of gravitational radiation.

Following such discoveries and the overall success of General Relativity, Blair and scientists like him are confident that not only will gravitational waves be detected, but that gravitational wave astronomy will allow scientists to peer deeper into some of the most energetic processes in the Universe than ever before.

Geoff McNamara is a freelance science writer who contributes to several Australian and international magazines. In closing he would like to thank David Blair and Chris Walsh for their help in preparing this story. ❖

STEREO FM TRANSMITTER KIT

NEW



Based on the BA1404 IC, which is used only for audio processing and derivation of the multiplexed stereo signal. This signal is then applied to a proven, very stable discrete FM transmitter which is very similar to our FM TX Mk2. The result is an FM STEREO transmitter which can be used with electret microphones and line level audio signals.

Specifications: Tuning range: 88 - 108MHz, supply voltage 6-12V, current consumption 8mA (@ 9V), pre-emphasis 75µs, pilot signal is crystal locked, frequency response 40Hz- 15kHz, S/N ratio better than 55dB, frequency stability with extreme antenna movements 0.03%, PCB dimensions 25 x 65mm. Kit includes PCB and all on-board components, 9V battery connector, wire for the antenna and two electret microphones: **$25**
Plastic case to suit: **$4**. (Kit available early in October.)

OVERSPEED MONITOR KIT

NEW

Install this unit into your vehicle and avoid hefty speeding fines! Unit produces a pulsed tone output when a certain preset speed is exceeded. The speed is set by a single calibrated potentiometer which is easy to adjust: travel at the desired speed and adjust the potentiometer until a tone is produced, then mark this speed on the dial for future reference.

Requires two connections to the vehicle's electrical system: +12V and ground. A small PCB is provided for the Hall effect pick-up sensor. This assembly is mounted near the drive shaft and connected to the main PCB by three wires. Kit includes two PCBs and all on-board components, a small speaker, and even two small powerful 'rare earth' magnets: **$22**
Plastic case to suit: **$4**. (Kit available early in October.)

POCKET SAMPLER KIT FOR PCs

NEW

See EA August 96. A data logger/sampler kit that connects to your computer via the parallel port. It can take samples over a 0-2V or 0-20V range, at intervals ranging from one per hour down to one per 100uS. Useful, for example, to monitor battery charging. It can also be used as a basic low frequency (to about 5Khz) oscilloscope! Our kit includes all on-board components, PCB, plastic box and software on 3.5" disk: **$25**

STEREO SPEAKER SETS

Total of four speakers to make two 2-way speakers. Quality European cloth surround bass - midrange speakers, used in upmarket stereo televisions, rectangular, 80 x 200mm. Tweeters are good quality cone types, 85mm square. 2 woofers & 2 tweeters. **$16** (Cat A02)

300W MOSFET POWER AMPLIFIER MODULE

A well constructed discrete audio amplifier module that uses eight 900V MOSFETs in the output. MOSFETs are mounted on a large heatsink that measures 280 x 125 x 40mm. You need +90V DC and -90V DC to get it operating. Use a 55 + 55V 300VA or larger transformer and 10000uF 100V electrolytic capacitors. **$200**

FM TRANSMITTER KIT - MkII

Ref: SC Oct 93. Low cost FM transmitter features 100m range, excellent frequency stability, tuning range 88-108MHz, supply voltage 6-12V. Easy to build, has a prewound coil in a shielded metal can. Includes PCB, all on-board components, electret microphone, 9V battery clip: **$12 ea.** or **3 for $33** (KII).

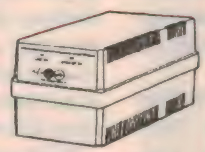
A suitable casing to allow this kit to be made into a wireless microphone is also available. Includes black aluminium tube, mic pop filter, unidirectional microphone & slide switch: **$10**

400x128 LCD MODULE

New Hitachi LM215 400 X 128 dot matrix LCDs in an attractive silver grey housing measuring 340 x 125 x 30mm. Driver ICs fitted but needs external controller. Effective display size 65 x 235mm. Basic data also provided. New and unused. **$25 ea or 3 for $60**

SPECIAL

AMERICAN UNINTERRUPTABLE POWER SUPPLY



New US made, modified square wave UPS in sealed box. Designed for 120V 60Hz operation. Easily modified for 50Hz operation. Very limited stocks at slightly more than the cost of the batteries that come with them: **$40** (250VA), **$60** (400VA)

CHECK OUT THESE ITEMS AND PRICES — VERY CAREFULLY!

New fresh stock of 1.2V/800mAh AA nicad batteries: **10 for $25**

New fresh stock of 12V/6.5AH SLR batteries (Hitachi): **$30 ea**

Constant current, mechanical timer battery charger: **$9**

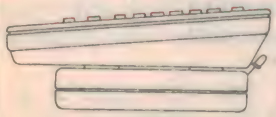
550-100mCd @ 20mA red LEDs (about 100 times brighter than standard LEDs), as used in car brakelight arrays: **100 for $25**

16mW/940nm @ 100mA IR LEDs. (High O/P, for remote controls etc): **10 for $5**

30mW/880nm @100mA IR LEDs. (Ideal for CCD camera illumination — much better than 940nm): **10 for $6**

THE ULTIMATE WIRELESS IR EXTENDER

NEW



This kit uses a UHF radio transmission to extend the range of any IR remote control. It will control your IR remote controlled appliances from any room in your house without any additional wiring! The UHF transmitter is fully self-contained (includes battery) and is attached with Velcro strap underneath the IR remote transmitter.

An IR sensitive pin diode at the front of the UHF transmitter picks up the IR signal. Transmitter has zero power consumption when the IR remote is not transmitting! The receiver is placed in the same room as the appliance being controlled and re-transmits the information to the appliance via two IR LEDs. Receiver requires a 5-12V DC supply or, with two additional components, a 24V DC supply. Complete kit includes two PCBs and all components, two plastic boxes, Velcro strap: **$35.** (9V battery for the transmitter is not supplied.) Suitable plugpack: **$10.**

SLA BATTERY BOOSTER

See SC July 96. This 'up' voltage switch mode inverter is designed to charge Sealed Lead Acid batteries and any other 12V lead acid batteries to their end point of 13.8V from 12V car or boat batteries. Also useful for many other applications. Our version includes extra RFI filtering, improved efficiency, and provision to increase the charging current from 2A to 3.5A. it's also easily modified for higher currents. Kit includes a 40A fast diode and a 40A MOSFET. Also included are a silk screened and solder masked PCB all on-board components, including prewound switching and filter transformers: **$25**

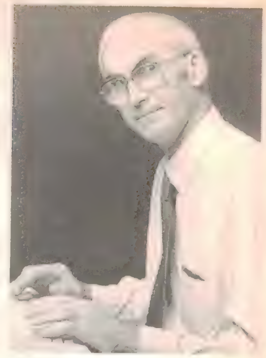
OATLEY ELECTRONICS

See inside of the back cover of the magazine for postal address, fax and phone numbers, web site and e-mail addresses, and **more** kits and items

READER INFO NO. 52

FORUM

Conducted by Jim Rowe



The possible health risks of E-M fields: more food for serious thought

In the August column, I reproduced a letter from an officer of the Australian Radiation Laboratory, who was somewhat scathing about comments made by both myself and correspondent Ms Betty Venables, regarding possible health risks associated with electromagnetic fields. Well, within days of that column being published I received a letter from a reader seeking to restore the balance, with both comments and a loan of some interesting literature. I also came across some interesting and relevant comments in *New Scientist* magazine...

You may recall that the critical letter in the August column came from a Mr David Samuels of the ARL, who seemed to take the view that both my own comments in the September 1995 leader, and Ms Venables' letter in the April issue supporting them, should be dismissed out of hand because they 'contributed nothing' to serious debate on the issue. He believed we had confused 'recommended safety levels' with 'safe levels of exposure', for a start, and suggested that because we lacked a sound knowledge of epidemiology and a 'conservative approach', we weren't in a position to make valid comments...

Anyway, that's the background. The new letter came from dentist Dr Tony O'Brien, of Charlestown in NSW, who not only made a few comments of his own but also very kindly sent in a number of reports he had acquired, for me to peruse on your behalf. More about these reports soon, though — first, let's read Dr O'Brien's own letter:

I have been following with some interest the discussions on EMR in Forum and elsewhere. Nowhere have I seen any mention of some of the very interesting and disturbing work that is being done in a number of places.

As far as I know, it started with the epidemiological work of Wurtheimer and Leeper performed in Denver about 20 years ago. It revealed a relationship between 60Hz magnetic fields associated with low voltage, high current street wiring and the incidence of childhood leukaemia in nearby houses. This work was repeated a few years later by Savitz.

In Sweden, Feychling and Ahlbom carried out a study in the residential environment involving a very large number of people (500,000) between 1960 and 1985. Their findings were that children exposed to more than 1 milliGauss had twice the incidence of leukaemia compared with control groups. Those exposed to above 2mG had three times, and those exposed to above 3mG nearly four times. The controls were exposed to less than 1mG.

An American researcher, Dr Robert Becker, suggests that ELF radiations could be one of the factors involved in a number of conditions. Namely SIDS, Depression and Suicide, and Chronic Fatigue Syndrome. SIDS infants have a very low blood level of melatonin, which is produced by the pineal gland. In experimental animals this gland has been shown to be very sensitive to EMR.

With regard to pregnancy and VDUs, McDonald in Canada, Bergqvist in Sweden and others have shown a marked increase in the incidence of miscarriages and birth defects in pregnant VDU workers. The Swedes have established a standard called MPRII which sets a level of 2.5mG at 50cm from the VDU. This is probably on the high side, especially for small children. The local occupational standard is 5000mG!

Some manufacturers have produced VDUs radiating only 0.4mG at 30cm.

I am sending separately three volumes which you may find of interest. Please peruse them and return in due course.

Here are some books for suggested reading, which I can recommend: 'The Body Electric' and 'Cross Currents', by Dr Robert Becker, and 'The Great Power Line Cover Up' and 'Currents of Death', by Paul Brodeur.

Becker is an orthopedic surgeon and researcher, with many peer-reviewed papers published. He is an authority on electrical stimulation of bone healing, and on the general electrical activity occurring in the body. A person with an electronic background would find his first book really fascinating — it discusses PN junctions in bone cells, to name one of his discoveries.

Brodeur is a journalist who was involved in the publicising of the asbestos threat.

Thank you for those comments, Dr O'Brien, and for the suggestions regarding further reading. I'm sure I won't be the only one keeping an eye out for the books concerned!

It's interesting that the work of researchers like Wurtheimer & Leeper, Savitz, Feychling & Ahlbom and Becker don't seem to be given much credence by people like Mr Samuels. I found myself wondering whether the criteria that the ARL and standards bodies use for deciding 'the best scientific evidence' and a suitable 'conservative approach' may not be quite as objective as they would like us to believe — and after all, words like 'best' and 'conservative' are essentially value judgements, aren't they?

Anyway, I'm very grateful to Dr O'Brien for his contribution, and also for his courtesy in sending in the additional reports. And getting back to the reports, I was able to spend a good few hours reading through them. To be honest some of the material in them was fairly heavy going, but there were many sections in each one that I found both interesting and informative.

In fact I found some of the material in these reports rather disturbing, and I suspect that many *EA* readers would have the same reaction. I get the feeling that quite a bit of the literature concerned seems to have been either ignored, or

somehow 'swept under the carpet', by both the authorities and the mass media. Which is surely a pity, as many of the research findings concerned are of direct relevance to the health and well being of a high proportion of us all.

This being the case, I believe it would be irresponsible of me *not* to give at least the titles of the reports here, along with any information I have on where they can be obtained. I'm also proposing to quote a few selected extracts — which is usually permissible in a 'review' — to give you a feeling for some of the ground they cover, and perhaps whet your appetite. I hope you'll find them as interesting and as thought-provoking as I did.

The first report

The first report is called 'Fields of Conflict', and was apparently prepared by a chap in Tasmania by the name of Don Maisch, originally as a reference and resource for Australian Democrats Senator Robert Bell. It's in A4 format and runs to about 115 pages.

I've spoken to Mr Maisch on the phone, and he admits that he's not a scientist himself. However he seems to have put a lot of effort into collecting and collating information on E-M fields and health, from researchers and publications around the world. I gather that some of the information in this report was featured in the ABC-TV 'Four Corners' program which prompted my own comments back in the September 1995 issue.

Subtitled 'A Report on Research into the Biological Effects of Electromagnetic Fields', the report is being continually updated. It is available directly from Mr Maisch, at EMFacts, of PO Box 96, North Hobart 7002, for $14.95 plus $8 express postage anywhere in Australia. Mr Maisch can also be contacted on (002) 43 0195, or by email: **maisch@ice.net.au**.

Incidentally Mr Maisch has also prepared a second report, titled 'Mobile Phones and their Transmitter Base Stations: The Evidence for Health Hazards'. Produced with the assistance of Senator Bell, this second report (which I haven't yet seen) is available for $35 + $8 express postage.

To give you just a taste for what's in the report, here's a small excerpt. It's actually part of a summary given in a letter sent last year by Senator Bell and Don Maisch to Standards Australia, when a SA committee was apparently considering an *increase* in maximum permissible E-M exposure levels (by a factor of FIVE):

In November 1993, the US Environmental Protection Agency (EPA) came out strongly against the US Federal Communications Commission's proposal to adopt the IEEE C95.1 standard on RF/MW exposure, contending that the standard has 'serious flaws'. The EPA questioned whether it is 'sufficiently protective of public health and safety'. The EPA criticised in particular the standards different limits for controlled and uncontrolled environments, and the failure to consider non-thermal effects.

In 1993, the Phillips Laboratory at Kirkland Air Force Base in New Mexico came out strongly for the existence of non-thermal RF/MW health risks.

Dr Cletus Kanary, a bio-effects researcher at the Phillips Lab, authored a white paper on the biological effects of RF/MW radiation in which he concluded that '...a comprehensive search of (the) worldwide literature' found that 'a large amount of data exists... to support the existence of chronic, non-thermal effects'. Kanary also noted in the white paper that 'The literature published in the late 1980's is abundant with information on non thermal effects

which are produced at levels below the ANSI standards'. In the ANSI/IEEE C95.1 standard, he added, 'The existence of non-thermal effects is essentially denied by omission'.

The (US) National Institute for Occupational Safety and Health (NIOSH) has also raised objections to the ANSI/IEEE C95.1 guidelines for basing exposure levels solely on thermal effects.

Dr Ross Adey, a leading researcher into EMR bio-effects, based at the VA Hospital in Loma Linda California, criticised the US Air Force for maintaining that EMR cannot cause non-thermal effects. At a hearing before a US Senate Subcommittee in August 1992, Adey testified that "As a matter of policy, the Air Force denies existence of biological effects, attributable to athermal fields. Nevertheless, evidence for athermal bio-effects is incontrovertible for both low frequency and RF exposures".

The above criticisms of the US standards apply equally well to the DR 95900, which is largely based on the American IEEE C95.1 standard mentioned above and only considers thermal effects. In light of the facts, to continue on this path of avoidance and omission is just the opposite of a proper scientific approach. It is a bit like the flat-earth controversy back in Galileo's time.

Paragraph 4 in DR95900 totally discredits the document's scientific validity due to its refusal to take athermal bio-effects into consideration, and its apparent ignorance of a large body of research. As such it should be rejected by both the Australian and New Zealand governments.

Well, there you are, and my thanks to Mr Maisch for allowing me to reproduce that excerpt. By the way, throughout the report there are reference numbers wherever a source is quoted (as in the section above), and there's a multi-page full list of references near the end — along with copies of letters from many of the original researchers.

CSIRO Report

Now to the second report sent in by Dr O'Brien. This is some 173 pages in length, again in A4 format, and was written by Dr Stan Barnett, of the CSIRO Division of Radiophysics.

Its full title is 'CSIRO Report on the Status of Research on the Biological Effects and Safety of Electromagnetic Radiation', and it's dated June 1994 although I gather that it was only made available to the public sometime last year, for reasons that are not clear.

I gather that in early 1994, the Spectrum Management Authority (SMA) asked the CSIRO's Division of Radiophysics to undertake a comprehensive review of world wide research results on the effects of radio frequency radiation on the human body, and Dr Barnett's report is essentially the summary of that review.

An interesting sidelight is that although the review was initiated by the SMA, apparently it was funded by the three Australian telecommunications carriers: Telstra, Optus and Vodafone. This is particularly interesting inasmuch as Dr Barnett's report, while very objective and balanced, still basically comes up with a fair bit of documented material on the adverse effects of RF fields on the human body — which is somewhat at odds with the public position adopted by the telecomm carriers.

I haven't had time to read through the report in full, but basically it seems to come up with a number of epidemiological studies which show an increased risk of developing diseases such as leukemia, eye cataracts and breast cancer, and at E-M field strengths well below the threshold for thermal effects. It also lists laboratory studies showing that adverse effects on the human immune system can occur at RF power levels many orders of magnitude smaller than the existing maximum radiation level of $1mW/cm^2$ — let alone the proposed level of five times this figure.

In short, even though the CSIRO/Barnett report is now a couple of years old, it still makes very informative and thought-provoking reading. I've also discovered that it's still available gratis from the SMA in Canberra, by contacting Ian McAlister of the Radiocommunications Standards Section. I believe that the number to call is (06) 256 5203, and the SMA will post a copy to you.

Again, just to give you a taste for what the report contains, here's an excerpt from the Executive Summary section:

The equivocal nature of much of the literature is of concern. Following discussions with a number of prominent researchers, insight into the situation has been somewhat clarified. It seems that in the past the subject of EMR bioeffects has suffered from: (a) lack of direction; (b) poor dosimetry (as the resolution of current numerical techniques were not available); (c) research studies based largely on the availability of equipment and biological systems within a particular organisation, i.e., no real attempt to predict a mechanism of interaction and match dosimetry, frequency and biological endpoint; (d) poorly described techniques; (e) obviously poor standard of peer-review, if any.

In many respects, the effects of exposure to RF from cellular phones should be relatively easy to determine because the radiation is emitted from the antenna close to the skull. Although the field becomes complicated due to interference by the head, numerical methods to estimate the SAR are improving. Values for the maximum power outputs are available and a number of studies are investigating the SAR levels expected in various adjacent tissues. In situ SAR values in the order of 3W/kg averaged over 10gm of tissue have been estimated in brain tissue close to a cellular telephone operating at 900MHz and maximum output. Under the same conditions the maximum SAR value averaged over 10gm of tissue was 4.6W/kg at 1.8GHz.

It is difficult to envisage an epidemiological survey that would effectively discriminate amongst the other environmental variables, including the many forms of EMR that exist in addition to cellular telephone or telecommunications frequencies. As a number of cellular responses have been associated with low level (50-60Hz) mains frequency, this may also be a potential confounding variable. The development of cancer is a slow process, taking many years before it is positively diagnosed in humans. The latency factor is very important in evaluating cancer development. It is most unlikely that retrospective studies will provide any useful information for recently developed technology, such as

cellular telephones. Prospective studies will have negligible chance of showing any effect, if present, in less than 10-20 years (Coleman 1994).

Concern over the lack of appropriate research was voiced by Frey (1988) in a chapter on evolution of research with low intensity ionising radiation. At that time he somewhat outspokenly claimed that 'the significant research, that which does not use high intensities and is not thermoregulatory oriented, has been largely squeezed out for reasons unrelated to science'. His concern was that while there is no doubt that there is a diversity of biological effects of low intensity RF radiation, the research to evaluate and understand these processes is not being undertaken, at least in the USA.

There is no doubt that the interpretation of bioeffects data has been clouded by a pre-occupation with thermally-mediated processes. In fact, development of the ANSI/IEEE standard is based only on well established thermal effects, and ignores the more subtle non-thermal processes that are more difficult to interpret and apply to human health.

Interesting, don't you think? Incidentally, that term 'SAR' is used throughout the report, and stands for *specific energy absorption rate*', a traditional measure of the rate of absorption of energy by biological tissue in animals or humans. It's expressed in watts per kilogram (W/kg), for the whole body or a specific part. Integrated over time, it gives the *specific energy absorption* in joules per kilogram (J/kg).

Another rather interesting section I found towards the end of the report is in reference to the pulsed output from digital cellular phones:

The GSM digital telephones have stronger peak electromagnetic fields than the analogue telephones, and have been shown to cause electromagnetic interference in a range of electronic medical equipment (Clifford et al 1994, Bassen et al 1994). Increasing the power of the GSM phone did not change the symptoms.

Many of the cellular responses, including transmembrane ionic flow, are elicited by RF emission that is modulated at around 100Hz, whereas exposure to continuous wave at the same fundamental RF frequency has no effect. There may be some reason to consider that the relatively high instantaneous power that causes EM interference may be the parameter that elicits responses in sensitive biological cell membrane receptors. This issue of critical exposure parameters is fundamental to an evaluation of potential health issues, and requires urgent investigation. The process of investigating underlying mechanism of interaction has had little direct attention to date.

Summarising, there's a lot of information in the CSIRO/Barnett report, and it's probably required reading for anyone wanting a good background on this important subject. I should also mention that there's a very comprehensive list of references at the end — some 23 pages of them, in fact.

Third report

Moving on, though, the third report sent in by Dr O'Brien was titled 'Potential and Actual Adverse Effects of Cellsite Microwave Radiation', and written by a Dr Neil Cherry of Canterbury in New Zealand. Dr Cherry is a physicist and Senior Lecturer at Lincoln University, and the report was apparently prepared by him when asked to give expert evidence in a hearing of the Christchurch City Council, regarding a dispute concerning the location of a cellular telephone base station.

Although a little shorter than the other two reports, Dr Cherry's report is very concise and readable and seems to give a good summary of the results of many relevant research studies around the world. It too is in A4 format, and ends with a list of useful references.

The Cherry report is available in Australia from Don Maisch, of EMFacts, PO Box 96, North Hobart 7002. The price is $14.95, plus $8 for express postage anywhere in Australia.

Here's a short excerpt from the Cherry report, taken from page 32 where he discusses the unwillingness of standards bodies to consider biological damage due to non-thermal levels of exposure:

The problem is that this was based on short-term, high exposure experiments and yet workers in military and industrial situations were exposed to long-term, low-level exposure. Papers were presented and published in the 1960s, pointing to defects in the procedures. Even at this time researchers were reporting reliable results of testicular damage in rats at 5 to 10mW/cm², brain changes between 12 and 64mW/cm², and changes in blood counts at about 13mW/cm². More and more of the researchers were becoming open to the possibility of non-thermal effects at or below C95.1. R.L. Carpenter brought a group together to gather the strands of research which pointed to non-thermal effects. Carpenter et al (1960) established hazard thresholds well below 100mW/cm².

Early in the 1950s, industrial corporations had adopted far stricter standards than the military, with Bell Telephone using a 100uW/cm² guideline as of 1953. On the other hand the military were still arguing against recognising non-thermal effects below 100,000uW/cm². The Carpenter group appeared to challenge the status quo. The question arises as to why was the standard C95.1 set at 10mW/cm², "just when scientific research was beginning to reveal how much more work remained to be done"?

The simplest answer, and the one advanced by Paul Brodeur, a major critic of past policy, is that many people involved in setting C95.1 "felt obliged to protect the 10mW level at all costs and to ignore, deny or, if the worst came to the worst, suppress any information about adverse effects of low-intensity microwave radiation". For Brodeur the values behind this are clear: "there was the belief in military preparedness and the presumption that a standard below 10mW/cm² would interfere with national defense".

The truth may not be as simple as this, but it is very clear that there was and still is a strong aversion to acknowledging even the possibility of adverse non-thermal effects in the official 'western' approach to standards setting, which has reluctantly progressed downwards from high accepted exposure levels because the technology which produced high levels of exposure were 'necessary' for military security or industrial development. The failure of people to develop visible adverse health effects in the first few years was taken as 'proof' that there were, and would not be, adverse health effects in the future.

Recently the Institute of Electrical and Electronics Engineers (IEEE) proposed a 1mW/cm² (1000uW/cm²) standard. Australia and New Zealand use a 1000uW/cm² occupational standard and a 200uW/cm² public exposure standard (NZS 6609). These are still based on a reluctant reduction, moving down from the thermal threshold rather than prudent avoidance on non-thermal effects which are now being suggested or identified at levels well below 200uW/cm².

Despite the information contained in this report, and information contained in a CSIRO in-depth review of the literature which identifies many non-thermal effects at exposure levels considerably below the 200uW/cm² standard (Doull and Curtain 1994 and Barnett 1994, the latter being a report which was precluded from discussion at the standards meeting by the Chairman, Dr Repacholi), there is now a proposal before a meeting of the joint Australia/New Zealand Standards Association sub-committee on radio frequency exposure standards, to raise the allowable exposure standard by a factor of FIVE.

Hopefully this excerpt gives you a good idea of the level of treatment, and the clarity of explanation, in the Cherry report. If you're interested in going further into this subject, I can recommend it too.

UK comment

Just before we end up this month, I also found an interesting and relevant comment in a letter to the editor published in the esteemed magazine *New Scientist*, in the issue for 20 July 1996. The letter was written by a John Simpson, on behalf of a British firm called Microshield Industries PLC, which makes and markets a device designed to reduce the level of RF field passing through the head of a cellular phone user, when it is transmitting.

Here's the section of the letter which I think you'll find of interest:

There are a number of published papers which have appeared in peer reviewed journals associating exposure to varying levels of radio frequency/microwave with various biological effects. When asked whether it was advisable to base RF/MW maximum exposure limits solely on thermal effects, Dr Ross Adey, who is Chairman of US National Council on Radiation Protection, said:

"The laboratory evidence for athermal effects of both extremely low frequency and RF/MW fields now constitutes a major body of scientific literature in peer reviewed journals. It is my personal view that to continue to ignore this work in the course of standard setting is irresponsible to the point of being a public scandal."

A Fellow of the Royal Society of Radiation Biologists, Dr John Holt, has carried out research which is shortly to be published and which confirms his statement that the radiation threat from mobile phones represented one of the most serious forms of radiation he had ever researched.

Epidemiological studies will be of no use for at least 10 to 15 years, but to deny that biological effects exist is somewhat naive. The manufacturers and networks themselves will admit reluctantly that they receive complaints from users ranging from headaches to ear, eye and skin problems. We have details of doctors who have confirmed that their patients have reported these symptoms, which have subsided once cellular phone usage has stopped.

There are currently at least two local authorities in England who have members of staff reporting these symptoms which have been relieved once they have ceased using their mobile phone. Both these employers have now arranged to supply Microshield cases to the staff involved. One of the National Radiological Protection Board's scientific advisers, Sir Richard Doll, will confirm that mobile phones can cause a change in temperature in the brain and it is not unreasonable to suggest that this might cause some damage.

In the meantime, we are offering mobile phone users a means of prudent avoidance against the RF/MW radiation emitted from their phone. The Microshield was designed by its inventor to cure his own headaches, experienced when using his mobile phone and already we have similar headache sufferers reporting a subsidence of their symptoms on using their Microshield.

As you can see from this, we're far from alone in thinking that a lot more research is needed in this area. As I've said previously, it would be a very foolish 'expert' indeed who would want to deny all possibility of a long-term health risk associated with today's official levels of exposure to electromagnetic radiation. In fact the situation seems a bit like that in the early days of using X-ray equipment, when radiologists and dentists unwittingly exposed themselves to cumulative doses of radiation that certainly caused no discernable short-term heating or other ill effects — but over a period of years turned out to cause all sorts of very nasty health problems.

If the radiation levels from things like cellular phones turn out to have similar long-term consequences, there are going to be some very unwell and unhappy people down the track.

I don't know about you, but I tend to agree with that last quote from Dr Adey. I can't understand how the standards people seem to be prepared to dismiss the 'warning signs' now fairly apparent in the scientific literature, and noted in reports like those I've mentioned and quoted from here.

But why not read these reports for yourself, and see what *you* think. ❖

AUTOMOTIVE ELECTRONICS

with JON LOUGHRON Assoc. Dip. Electronics

Engine management in Mitsubishi's TN Magna

This month we look at the engine management system in Mitsubishi's TN Magna, introduced in 1987. This employs a full management system to control the fuel, spark and idle requirements for the multipoint injection, unleaded four cylinder 2.6-litre engine. The system has the necessary input and output peripheral devices so that the ECM can provide maximum fuel efficiency, power, maintain good idle quality and minimise harmful emissions.

A novel feature of the TM Magna system (also found on other Mitsubishi vehicles) is the way in which engine load (intake air flow) is measured. The airflow meter is a 'vortex' type meter, which means it measures air flow differently from other systems on the market. As discussed in previous articles there are vane type AFM's, hot-wire air mass meters (AMM), hot-film air mass meters and also manifold absolute pressure (MAP) sensors.

The vortex AFM generates a frequency according to air flow. This in itself is not so special, but how the frequency is generated is very interesting. There is a vortex-generating rod inside the AFM that disturbs the air into clockwise and anti-clockwise vortices. The delay between the two vortices can be measured by infra-red or ultra-sonic transducers and an output signal frequency is then derived. The ECM then uses this frequency to provide the correct fuel injection for the incoming air.

Naturally the coolant temp sensor and air temperature sensor also provide relative engine information so that injection time can be trimmed for optimum fuelling.

The TN Magna ECM is a digital type computer with a microprocessor, RAM, ROM and interface circuitry, and it also has fault code retention and recall. It has two connectors, of which the green 13-pin connector (A) has the main power supply (+12 volts and earths), the four injector stage outputs (sequential injection), ignition control, and signal inputs to sense air conditioner operation and cranking (starting).

The 24-pin yellow connector (B) has the various input and output sensors connected to it. A summary of the various ECM connections can be seen in Fig.1.

Power supplies

Constant +12V power is connected to the ECM via pin A13. This is done to ensure fault codes are saved even after the ignition key is switched off. When the ignition key is in the ON position, +12V is supplied to pins A1 and A7.

Once the ECM is fired up, it in turn supplies +12V to the Hall sensor located inside the distributor, for ignition system triggering, via pin number B9. Similarly the +5V supply for the TPS, AFM and ISC motor position sensor appears on pin number B10.

The main earths for the ECM are located on pin numbers A2 and A3, while the earth for the coolant temperature, motor position, air flow and throttle position sensors is on pin number B4.

The normal precautions apply when testing the power supplies and grounds. Ensure that all connections are tight and

Fig.1 (left): There are two external connectors for the Magna ECM, one of 13 pins (A) and the other of 24 pins (B). Here are the functions for each of the pins on both.

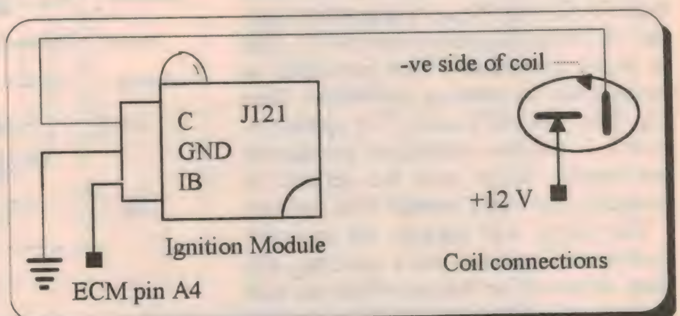


Fig.4 (above):The conections for the 'ignitor' or ignition module, and also for the primary side of the ignition coil.

free of any oxidisation. It also should be noted that the switched power for the system is supplied via the engine control relay, which is located in the passenger side footwell behind the kick panel — next to the ECM itself.

I have had a few non-start vehicles where this relay was intermittantly malfunctioning. A light tap on the relay cover would rectify the problem, so a replacement relay was then installed.

While we are on the subject of power supplies, it's important to ensure that the alternator regulator and wiring is in good nick. This is because an open-circuit charge voltage is sometimes a problem with this system, and the ECM does not like the voltages generated under open-circuit charge conditions. A wiring modification may also be required which entails a 4mm wire being connected between the alternator and the battery. It is probably best to consult your local auto electrician regarding this modification.

Fuel system

The Magna fuel system is like any other multipoint system — it has all the necessary parts, such as the in-tank fuel pump, supply and return line, filter, fuel rail, injectors and fuel pressure regulator. The system pressure is set to approximately 196kPa at idle, and 245-265kPa with 0 vacuum (atmospheric pressure) applied to the regulator. The regulator has a vacuum hose attached to it so that the fuel pressure increases and decreases in sympathy with engine vacuum — except when it doesn't!

To explain the above contradiction, it happens that the vacuum to the regulator is actually switched via the Fuel Pressure Control Valve (FPCV — similar to the VL Commodore). The FPCV will switch atmospheric pressure to the fuel pressure regulator when the coolant temperature sensor (CTS) reads more than 90°C, and the air temperature sensor (ATS) reads greater than 50°C. This is done to increase fuel pressure, to assist with hot starting conditions. (See Fig.2 for the ATS and CTS specifications). If the two conditions mentioned previously occur and the engine is cranking, the valve should then operate.

The valve will operate for approximately two minutes after starting, and then switch off so that manifold vacuum is then re-applied to the fuel pressure regulator for normal running conditions.

As mentioned, power to the fuel pump and ECM is supplied by the fuel control relay and this relay is energised by either cranking the engine, by +12V from the ignition switch (ignition key in the 'on' position) or from the ECM itself, via pin 22 (self-hold function) once the the ECM sees a system trigger. See Fig.3 for the relay connections.

The other main fuel components are the injectors. The TN Magna being a multipoint four cylinder vehicle, naturally there are four injectors. These each have a resistance of approximately 16 ohms and operate in sequential mode — which explains the fact that each injector has an individual transistor driver stage inside the ECM.

An in-tank additive can be used to keep the injectors clean, but if they do get a bit grubby the best way (in my opinion anyway, which may matter to some and not to others) to ensure that they are clean is to remove them from the vehicle for testing and cleaning. Then the patterns and leak-down can be checked visually — although some of the on-car cleaners these days are pretty efficient.

Temp.	CTS*	ATS*
0 Deg. C.	5.6 K Ohms	5.6 K Ohms
20 Deg. C.	2.5 K Ohms	2.6 K Ohms
40 Deg. C.	1.1 K Ohms	1.1 K Ohms
80 Deg. C.	300 Ohms	320 Ohms

Fig.2 (above): The resistance vs temperature specifications for the coolant temperature sensor (CTS) and air temperature sensor (ATS). Note that the figures are only approximate.

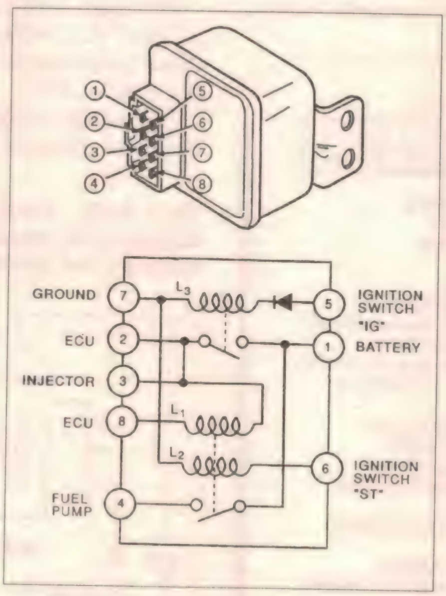


Fig.3: The connections for the fuel control relay, reproduced here by courtesy of the VACC Technical Department.

Ignition

The ignition system is controlled by the the ECM. The timing and dwell are determined by the various inputs to the ECM, and the drive signal for the external power stage (often called an ignitor) is provided on pin number A4.

The ignitor power stage is basically a three-pin power transistor (well the diagrams show it as that, but it may have a little more trickery inside), with the emitter connected to ground, the base (IB) to pin A4 of the ECM and the collector (OC) to the negative side of the ignition coil primary. Testing the unit is relatively easy, and can be done by triggering the base with a standard LED tester. If the ignition coil is OK and power and ground leads intact, a spark should be evident out of the secondary side of the coil.

As a reminder, though, always be carefull when testing modern ignition systems as dangerous potentials exist on both the primary and secondary circuits. Also ensure that you have a recommended spark gap tester when testing for spark — because if the tester gap is too wide the kilovolts of energy generated must go somewhere. This means it could return back through the coil and destroy some of the primary components, so be careful!

Idle speed, timing

The idle speed adjustment is sometimes a complex operation and it is factory set — so only adjust it when an idle problem actually exists. The system (not the adjustment) is similar to the EA CFI Ford, which employs a throttle 'nudger'.

If idle problems do exist, the first thing that must be done is ensure that the throttle body and throttle plate are clean. You may find that somebody has adjusted the throttle stop screw to overcome a low idle problem, caused by a dirty throttle body. In this case if the throttle body and plate are dirty, they will have to be cleaned and the idle speed *will* have to be reset.

The nudger has a switch in the end of it to inform the ECM of when the nudger is touching the throttle linkage. There is also an idle speed motor position sensor, to provide feedback to the ECM regarding the nudger position when the engine is *not* in idle mode.

To adjust base idle speed, ensure that the engine is at operating temperature and all external loads are off — i.e. air conditioning, headlights etc. Start the engine and adjust the throttle butterfly stop screw from the driver's side of the car to (800 +/-50)rpm.

After you have adjusted base idle then the throttle position sensor (TPS) should be adjusted to give 0.5 volts — because

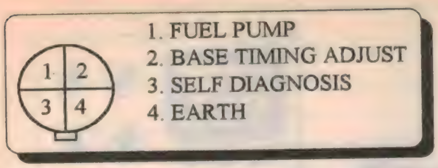


Fig.5: The connections for the test signal socket, located near the passenger side shock absorber tower.

by adjusting the butterfly screw, you change the TPS voltage. Then turn the engine off, and to reset the ECM disconnect the battery for a short duration, approximately 10 seconds.

Then reconnect the battery and start the engine. If idle speed problems still exist, then there may be a faulty idle component or power supply problems. As always, if in doubt don't touch; get your local automotive technician to have a look at it. Or if you are an automotive technician — read the manual!

Base timing is adjusted with the engine at operating temperature, with all external loads off and the idle speed correct. Connect a jumper wire between the spark advance terminal and ground on the four-pin check connector (see Fig.5), and set the timing to 5° BTDC (+/-2°). If the timing is not correct, do this by rotating the distributor.

While we are talking distributors, it should be noted that inside it are two Hall sensors which perform system triggering. Power supply for the trigger comes from ECM pin number 9B. The outputs from the two sensors are the crankshaft reference signal ECM (pin number 1B), which generates a square wave signal, and the number one cylinder TDC (top dead centre) position signal.

When testing a vehicle that has no spark and no injection, and therefore a 'non start' condition (and assuming that the relay mentioned above and power supplies have been checked), it would be wise to check the power supply to the distributor plug. Also with an oscilloscope, check for switching activity from both hall sensors. **Never check a Hall sensor with the ohms range of your multimeter, because it may damage the sensor.**

Fault codes

As noted earlier, the ECM can provide system fault diagnostic codes which may indicate either a permanent problem or an intermittent problem that may have been logged into memory. To observe the code output, you use the same connector that was used to adjust base timing. The pinout for the connector is shown in Fig.5; the diagnostic code pulses appear at pin 3.

The codes are generated contiuously and can be read with a multimeter or a LED test lamp — although an oscilloscope or a dedicated automotive decoder is probably the best way, because of the unusual way the codes are transmitted. (Mitsubishi dealerships have a special tool for reading the codes, called a MUT tester.) The codes are generated in a binary fashion and the output can be seen in Fig.6.

Note that there's even a 'normal' code, with five long '0' pulses, and this is worth remembering. If the system power supplies and earths are intact but the ECM is producing no codes at all at the code pin (or pin number 21B at the ECM), I would not be surprised if the ECM is 'brain dead' and will need replacing. But if you do see this problem (i.e., no codes at all), please ensure, as mentioned above that all supplies are correct and the relevant wiring is intact. Otherwise you could replace a perfectly good ECM...

Why a LED tester?

Well, that just about wraps it up for another month, except that I had a letter from a reader from sunny Queensland (Mr A.N. Brookes of North Mackay), regarding the Bosch EST article. Mr Brooks asked why I recommened a LED tester to get codes from the XF EST system — he mentioned that the Ford manual recommends a multimeter or a systems diagnostic unit, T2100U/B.

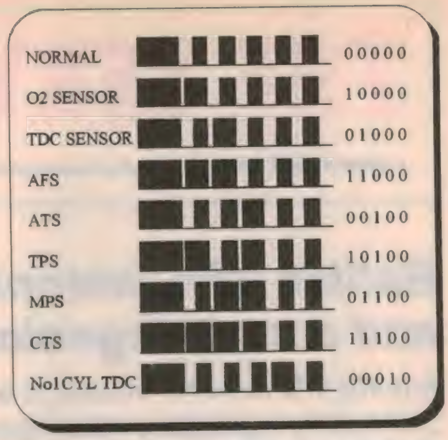


Fig.6: The Magna ECM's self-diagnostic codes, available at pin 3 of the test signal socket. They consist of groups of five pulses,which have two widths depending on whether they represent a binary '1' or '0'.

The answer is quite simple: LED testers are cheap.

He also had some interesting mechanical observations, regarding the installation of the incorrect distributor to the XF EST/EECIV systems. This may be my fault for not making things totally clear, in that it *is* possible to swap the Hall sensors (although not the entire distributor) on the EST and EECIV vehicles.

As can be seen from Fig.7, the base plate is the same but the position of the Hall sensor is out by approximately 30° — so if they *are* interchanged, it does cause a very interesting complication!

Thanks for taking the time to write, Mr Brookes, and I hope this explains the main thrust of what I was explaining with regard to the XF's EST/EECIV Hall sensor dilemma.

Until next time, 'bye.

(*Editor's Note: Due to unfortunate 'gremlins' in our desktop publishing system, some of the recent Automotive Electronics columns were wrongly attributed in the stock heading 'by-line' to Nick de Vries, rather than Jon Loughron. In fact Jon Loughron has written all of these columns since and including that on the VL Commodore's ECCS III system, in the March issue, and we apologise to both Jon and his readers for the mixup. We're fairly confident that the columns should be correctly attributed from now on.*) ❖

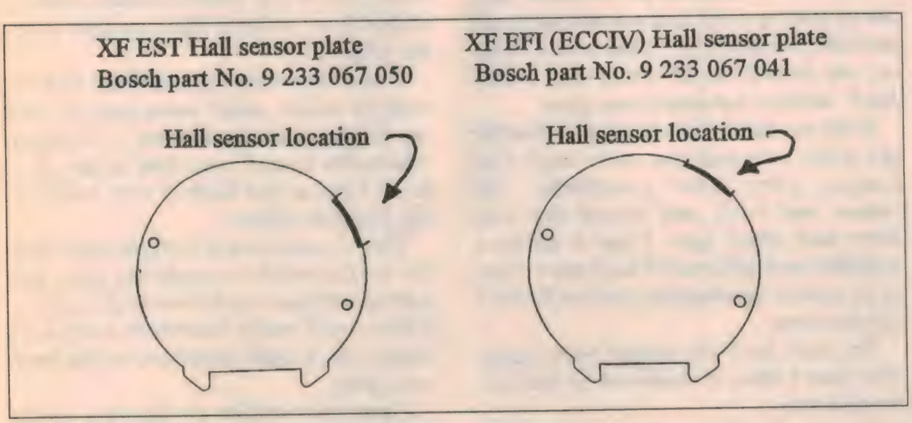


Fig.7: The Hall Sensor plates for Falcon XF FEFI and EST systems compared, showing the different locations for the Hall sensor relative to the mounting screws. This causes a timing problem if the incorrect one is installed.

THE SERVICEMAN

Battles with intermittent colour, and a most ingenious repair!

Among this month's stories is a tale from an anonymous contributor, about a Healing CTV with a particularly frustrating intermittent colour problem. In addition we have a story about a most ingenious (but foolish) 'bush repair' by a handyman owner, and also one about trying to resurrect a dead Masuda TV with a most unhelpful schematic diagram...

There's nothing more disappointing to an editor than a good story from an anonymous contributor. A name and address on the story, whether it's on a typed sheet or computer disk, gives us a degree of confidence that the story is authentic and can be verified.

Then again, if there are any doubtful points about the story, we can contact the author for clarification before publication. We make every effort to see that the details given in these pages are as accurate as possible, but without a name to contact, it can be very difficult.

All of which is leading up to the first story for this month. It's from somebody, somewhere, who took a lot of trouble to write his tale and send me a typed copy plus a computer disk. Not only that, but he also included a copy of the old DOS word processor programme that he had used to write the story...

He made sure that there was really no reason why I shouldn't read and (hopefully) use his story. Except that he forgot to include his name and address, either on the typed copy or the disk. There may have been a return address on the package that the story arrived in, but that has long since been discarded (or recycled).

So, whoever you are, if you recognise your story and can convince us that you are the author, we would like to hear from you. If nothing else, it will make sending you your contributor's cheque a lot easier.

In the meantime, here's what Mr Anonymous has to say...

I won the war, but the battle went on for weeks!

It all started over a Healing CTV Model R3452, which had lost colour. The chroma board on this model is the middle one of three plug-in boards, all so jammed together that you can do nothing while the board is in place. The normal cause of this fault is dirty pins and socket, so I pulled it out and cleaned both. The colour came back, so I returned the set to its owner. It was eight days later when the colour went again!

This time I made up an extension lead out of ribbon cable and got the set going with the board laying on the bench. A tap on the board would bring the colour back; another tap and it was gone.

It did not take much looking to find the dry joint, so it and any other suspicious looking joints were resoldered. The colour was back, and stayed that way even with sharp taps. I put it all back together and delivered it back once more to its owner, apologising for not fixing it the first time.

Ten days later the colour went again. This time I knew it could not be bad soldered joints...

So with the chroma board once more on its extension lead, I got the CRO to work and soon found the trouble was that the 4.43MHz crystal circuit would stop oscillating sometimes when the board was tapped. I had lent the customer a set, as I was determined that I would not return this one until it had been tested for a week or more.

The fault would disappear for a day or two and would then come back. After studying the circuit for some time, I decided to replace one by one the few components that make up the oscillator stage. First the crystal, then the two 47pF ceramic capacitors. But the trouble was that after I had changed a component, the colour would come back for a day or more and I would have to wait until the fault decided to return before I could go on with the search.

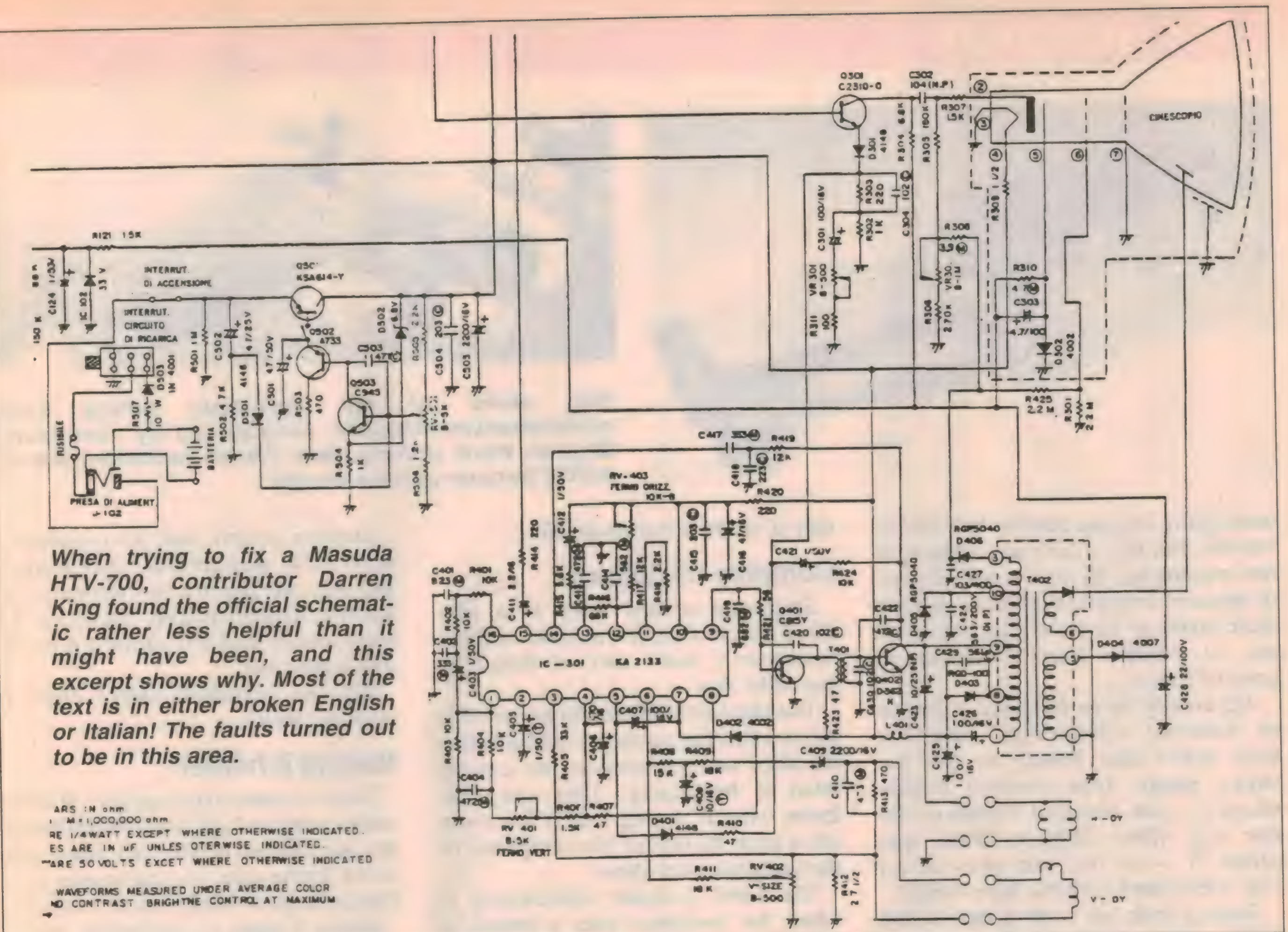
When I had changed all the components and the fault still persisted, there was only the IC left. I never thought for a minute that it could be faulty, but what other option was there?

Once having got a replacement, I prepared the soldering iron and solder sucker for the attack. I started at pin 15, in the top left-hand quarter. But then I noticed that all the pins of this IC had been bent over, flat to the board. Which meant I would have to bend them upright to get the chip out...

It was then that I found there was not enough solder under some pins to suck up. In this kind of situation, it is almost impossible to melt what little solder there is, so I put a nice blob of new solder on the first row of pins.

Then I wondered if it might have been the lack of solder around the pins, that had caused the trouble in the first place. There could easily have been a dry joint there, out of sight under one of the bent-over pins.

I put new solder on the rest of the pins, then switched on — and found that this had indeed been the problem all along. Mind you, I left it running



When trying to fix a Masuda HTV-700, contributor Darren King found the official schematic rather less helpful than it might have been, and this excerpt shows why. Most of the text is in either broken English or Italian! The faults turned out to be in this area.

for a week, just to make sure.

Financially the job was a dead loss, but the relief to my mind was payment in full.

So, there it is. Dry joints can take all forms, and the worst of all forms is the invisible one. In fact, however, this kind of dry joint is not all that uncommon.

Component leads often have to be bent over during assembly, to stop the item falling out when the board is inverted for inspection. This, coupled with the fact that wave soldering machines used on most production lines apply a bare minimum of solder to the board, helps to ensure that there are often voids under the pins when the process is completed.

Although it is time-consuming, the best plan of action is to resolder every joint in any circuit that is suspected of harbouring a dry joint. As Mr Anon's story shows, they can be hiding anywhere.

But please — don't forget your name and address on your contribution.

Ingenious repair!

Now we come to a couple of contributions from our Tasmanian correspondent Stephen Ward. We've had a number of stories from Stephen, most of them straightforward tales of searches for confusing faults. This time he gives us an insight into some of the funny (peculiar) folk that live around his part of the Island State.

A few months back, I used a story from a contributor that described an ingenious repair to an integrated circuit. The perpetrator of that exercise displayed all the skill and guile of the traditional Aussie handyman. Well, I've found another one. Or at least, Stephen Ward has found another one!

A week or two back I received a small package from Stephen, and I wondered why his contribution should come in a packet.

I soon found out because when I opened the package, there was a small rotary TV tuner with the most extraordinary modification I have ever seen. A covering note from Stephen said that readers might be interested in seeing how some people went about repairing their TVs...

It seems that this particular owner lived far out in the bush and when the tuning knob broke off his Sanyo CTV, he cast around for something that he could use to replace it.

In his workshop he found an old brass water tap and decided that the handle would make a good tuner knob! But that was only the beginning of his difficulties, because he then had to find a way to fix the handle to the tuner shaft.

We aren't privy to the details of how he went about this task, but somehow he drilled holes into the tuner and tap handle shafts, then found and fitted a short length of splined brass rod to connect the two together. The amazing thing about the whole job is that it was done *in situ*, with the tuner still mounted in the television set!

Although the join is quite rigid, he apparently felt that the parts should be soldered together and he tried to do this — with spirits of salts and a plumber's iron! Unfortunately, the join was too close to the set's plastic front panel and the escutcheon did not like the proximity of a hot iron. In the soldering process it got severely melted.

The owner looked with pride on his makeshift repair job, then plugged the set into the power and switched on. The moment of truth came when he tried to change channels with the new knob.

The knob gave him a savage 'bite' that threw him across the room. He

Two views of the ingenious tuning knob replacement/modification encountered by contributor Stephen Ward. Unfortunately the set concerned was an AC/DC transformerless design...

tried again, and got another belt for his trouble. But this owner was nothing if not resourceful. He took a roll of plastic tape and wrapped the handle in 10 or more layers of tape. At least this made the set useable, even if it was an unsightly mess...

Apparently there followed a period of domestic disharmony, since his wife didn't like having to use the sticky plastic tape covered handle whenever she changed channels. So that was when Stephen Ward was called in — to find out why the set 'bit' when used with the bare handle.

Stephen took one look at the set and told the owner exactly how foolish he had been. This particular Sanyo has a live chassis, and the owner had used a metal handle for his repair! Stephen tried to explain about live chasses and half mains voltage, and those sorts of things, but the owner really hadn't a clue.

In the end, the wife drew the line and decided she would not put up with the taped knob and the ugly burn marks on the front panel. She had decided that they were going to have a new TV. So there!

Eventually they did, and the old Sanyo landed in Stephen's workshop. That was how he was able to recover the modified tuner and send it to me.

The whole story is quite remarkable for two reasons. One is the ingenuity of the owner in selecting, of all things, a tap handle for a tuning knob. The other is the skill with which he effected the repair, using only simple hand tools. I suspect that *I* couldn't do that job with a proper bench drill and the tuner set up in a vice — let alone with a hand drill on a tuner still mounted in the set!

It's sometimes said by their detractors that many Tasmanians have two heads, but if two heads makes possible clever (though ill-considered) emergency repairs like this, then maybe they'd not be a bad possession...

Complex complaint

Stephen's second story is a very short one. In fact, it's another of those 'customer's note' sort of things. It goes like this:

The ideal introduction to any service job is when the customer brings it into the shop and explains to you exactly what is happening. They may not know what is wrong, but at least you get a clear picture of the symptoms as the customer sees them.

The worst possible introduction is when the customer asks a friend to drop the set off and gives no more explicit instructions than "...ask him to fix it for me".

There is an in-between state where the customer sends in a garbled version of the symptoms, either via the friend or by way of a note attached to the set. It was just such a note that charged Stephen Ward with repairing a Sharp video cassette recorder. The note read:

WHAT IS WRONG WITH THE VHS?

It will not eject without a 'secret' coded message.

Press stop, press eject, and then a varied selection of your choice at random and if you are lucky, after six or seven goes, the tape appears!

Sometimes have similar problems when trying to record, though here it ejects or stops whenever the machine fancies.

The VHS even turns itself off when we are trying to record on occasions.

It has a mind of its own!

The picture is still good, and when 'it' so desires we have no problems...

Well, that's what the customer said. And what do you think could cause that parade of symptoms? Would you believe a faulty Mode Switch? In fact that is what it turned out to be.

Stephen asserts that the customer's description was accurate, but useless. Yet once he saw the performance for himself, he immediately suspected the mode switch and soon proved it by fitting a new one.

But the customers don't make it easy, do they?

Making it harder

Now we move on to another of those stories about old and unloved equipment that are restored to life with just a little tender loving care. The tale comes from Darren King, of Pakenham, in Victoria.

Darren's story is interesting not so much from the technical side but more as an example of just what you can do without a proper circuit diagram. As you'll see, Darren had to apply a lot of sound general knowledge to make sense of a not very useful diagram. Here's what he has to say...

I have been an avid reader of EA for about 12 years now, and the first thing I turn to when my copy arrives by post every month is 'The Serviceman'. I reckon that it is now my turn to contribute a short but rather amusing story, concerning a television I have just repaired. I hope you can use it.

I am not a full time electronics serviceman where television and video equipment is concerned. My full time employment is with the Victorian Railways, where I am a Signal and Communications technician. This involves more electrical principles than electronics, as it is mainly relay logic.

However my work also involves maintenance and repair of telephone and telemetry equipment too, which can be quite complex in circuitry at times. But, as other contributors to this column have pointed out, I also have to deal with the fact that because I have a technical background, in the eyes of the people I know it

qualifies me to be an expert in repairing videos, televisions and computers.

So much so that I now spend quite a bit of spare time looking at their faulty equipment and although I am not the fastest fault finder, I do know my way around televisions, videos, audio and computer equipment. And may I also add that I do get a great deal of pleasure from 'bringing back the dead and injured'.

Anyway, my story starts with a visit to a local garage sale, where I found a seven-inch portable black and white Masuda television model HTV-700. It was in very good condition and the price tag said 'Doesn't Go. $25' I thought it would be a great addition as a test unit, instead of having to set up a much larger television to perform the testing of videos.

It was getting late in the day, so it was quite easy to talk the owner down a bit. Back at home I took the cover off and luckily the innards had not been tampered with. The first step was to apply power and see what it did. Nothing. Well, at least the price tag was right in that respect!

Out came the multimeter, and with a bit of board tracing I was able to locate the voltage regulator circuit. While trying to take a measurement on the collector of Q503 the set sprang into life! (Well, sort of). I had sound, the tube heater was glowing and a sort of EHT whistle was present — although the screen was black with not even a trace of raster.

Any voltages measured around the neck of the picture tube and EHT transformer made no sense at all either. So it was time to call the local Masuda importers for a circuit diagram.

This duly arrived, but I have to label this circuit as the worst so far I have in my collection. I have included a copy for you. It appears to be quite normal until you look more closely at it.

All the 'Notes' are in misspelled and broken English, while the labels for various parts are in something else again (Italian?). Voltages or waveforms? Forget it! None to be seen. Well, it was a circuit with relatively standard symbols and that is what I ordered, I suppose...

I had a fair idea that the fault of 'no picture' was around the EHT transformer as the CRO showed a reasonable drive waveform on the horizontal output transistor Q402. But I could not find any voltages on D404 or D406, feeding the tuning voltage and CRT screen supply rails respectively.

I did have rail voltage through L401 to the anode of D403, but the cathode of D403 had nothing. It seemed to be OK when tested in circuit, but when I checked its markings, the diode was not an 'RGD-10D' as indicated on the circuit. It was nothing more than a humble 1N4002.

I pulled out the diode and tested it more carefully. It was open circuit. On further investigation I found that D402, which should be a 1N4002, was in fact the 'RGD-10D'. It looks like the board had not been assembled correctly!

I swapped the RGD-10D to its correct location, and fitted a new 1N4002. I now had a very nice looking picture to go with the sound. Now back to the 'need for a kick start to get going' problem.

The voltage regulator circuit seems pretty straightforward at first glance but it does have a couple of odd features. Firstly the On/Off switch is in the base leg of the series bypass transistor Q501. And secondly, the combination of C502, R502 and D501 seems to form a time constant circuit of some description.

I thought it may be these parts which could be causing the start up problem (what else do you need a time constant in a regulator circuit for?), and I was right. D501 was open circuit. A new diode restored the set to full operation and it has proved to be a very nice little television and ideal for my testing purposes.

Finally, some of the labelling on the circuit is very strange indeed. For example, Horizontal Hold is 'FERMO ORIZZ' and Vertical Hold is 'FERMO VERT'. The picture tube is a 'CINESCOPIO', while the speaker and tuner module are unpronounceable! Then, the markings 'PRESA DI ALIMENT' is the external DC input and 'INTERRUT CIRCUITO DI RICARIA' is the Battery Charge Switch. Wouldn't have been so much simpler to print these labels in English?

You're right of course, Darren. But then we don't know the history of this diagram. My guess is that it was originally printed in broken English for the UK and USA markets, then modified in a few key places to suit the Italian market. I'm not sure, but I think you're right about those labels being in Italian.

I'm intrigued by the label on the tuner, which is 'SINTONIZZATORE' — and seems to have been produced by Sam Sung! (Not a very Italian name!) I wonder if the Italians are as amused by labels in English?

Thanks for that item, Darren. It just goes to show what you can achieve with minimum information and maximum enthusiasm.

Well, that's all for this month. I've got an unusually interesting story to head next month's column, so watch out for it. In the meantime, let us have *your* contribution. It might bring you fame and a little bit of fortune. ❖

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide any further information.

Clock alarm driven remote switch

Here is a circuit I designed to interface between my clock radio and an inexpensive UHF transmitter kit from Oatley Electronics which in turn is used to remotely turn on (or off) any mains appliance when the alarm goes off in the morning. The receiver unit was also from Oatley Electronics and is used to switch a 240V relay powered from the mains via an appropriate transformer and regulated power supply circuit.

Before describing the circuit note that with a multimeter and logic probe the appropriate signal outputs can be found in just about any clock radio, as most share the same basic features although the logic levels may be reversed in some cases. Power for the circuit is also 'borrowed' from the clock radio in question.

The 'alarm-triggered' output from the clock radio feeds into the circuitry around C1, D1, Q1 and R1, and serve to clean up the noisy input signal so that it can clock flipflop IC1 via the 'OR' gate made up from D2 and D3. C2 and R3 are used as a power-on reset to ensure that the Q output goes high when power is applied.

The alarm on/off switch from the clock radio is normally high when off — ensuring that Q and Q-bar retain the appropriate logic levels regardless of false triggering from noise etc. on the clock input pin 3, by keeping the Set input high. It also resets the flip-flop, once triggered, when the switch is returned to the "off" position.

When the switch is on, the level on the Set input is pulled low by R3. The flipflop is then free to toggle when clocked which occurs when the alarm goes off, sending a low to high level to the flipflop's clock input. It is important that the flipflop is not triggered again, particularly if you have pressed the snooze button, as this will turn off whatever was just turned on (or vice-versa). So the Q-bar output is tied back to pin 3 of IC1 via D3 which blocks any further clock pulses from reaching the flipflop, keeping the clock input high regardless of the level at D2.

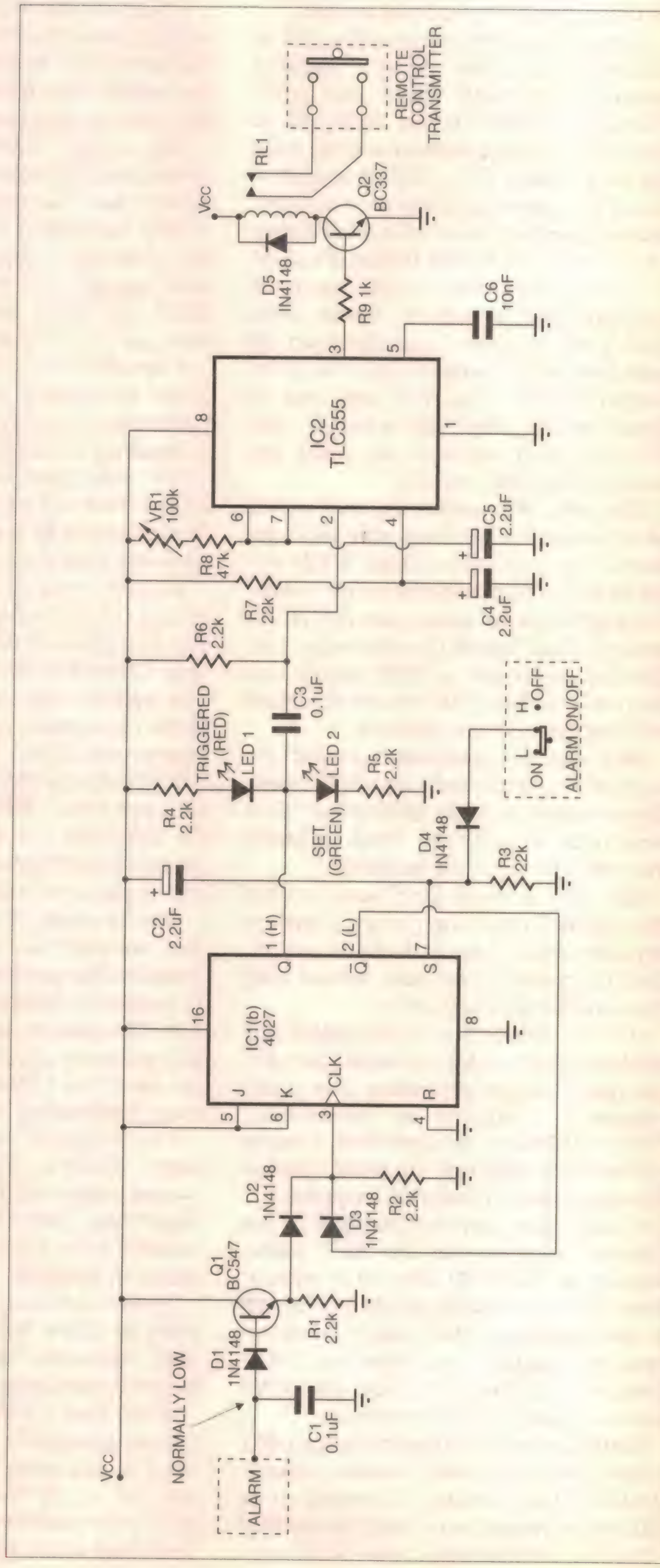
Once the flipflop is triggered, the normally high Q output goes low which delivers a momentary low pulse through C3 to the trigger input of IC2, a 555 configured to operate in monostable mode. Most UHF transmitters require that the button be pressed for a minimum time to deliver the full train of coded pulses, say half a second or so, but not too long so as to keep retriggering the receiver. So in this case C5, R8 and VR1 are used to ensure the pulse width from pin 3 of IC2 is neither too short nor too long.

Note R7 and C4 are also used as a power-on reset to prevent the 555 false triggering in the event of temporary power loss.

The pulse output from the 555 drives the relay through Q2, pulling the relay on then off again. The normally open outputs are wired in parallel to the momentary power button on the remote control transmitter. The transmitter has a hole in the underside to accept the wires and is secured to the wall nearby via Blu Tak — the transmitter's button is therefore easily accessible to allow 'manual override' at any time.

Kerry Helman
Adelaide SA $40

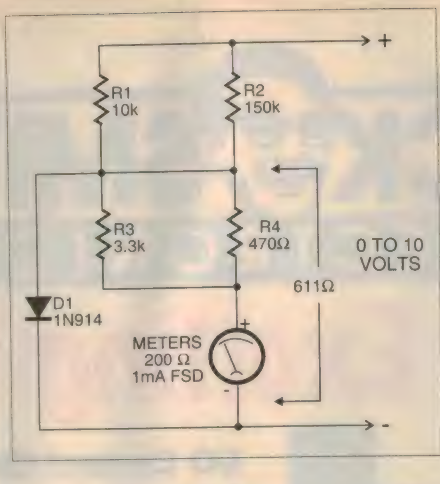
THIS MONTH'S PRIZEWINNER!

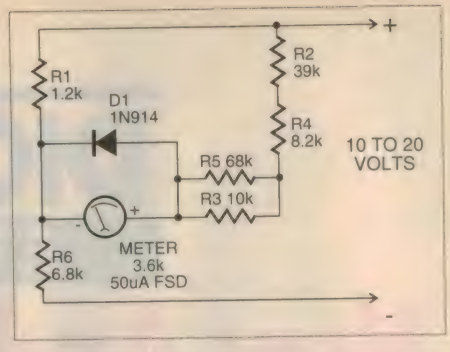


Meter overvoltage protector

These circuits were devised after an apprentice technician 'borrowed' my old but trusty multimeter, saying he wanted to check for 240 volts on a GPO. Fine, except for the meter. He had it set to 250 *millivolts*! Needless to say, the meter was rapidly consigned to the junk box.

I've used these circuits more than once; the name of the game is to fiddle with standard E12 resistor values to achieve two distinct resistances. The upper parallel combination gives a value for the damping resistor, and the lower value is small enough to prevent the diode from conducting with less than 10V applied. If the voltage rises above 10V, the diode conducts and the meter only experiences a voltage it can tolerate mechanically.





The same concept can be applied to other meter movements; I've done the maths for a 50uA meter, as shown in the second diagram. Note that all resistors must be 1% tolerance or better.

Peter Lucock
Wynnum West, Queensland **$30**

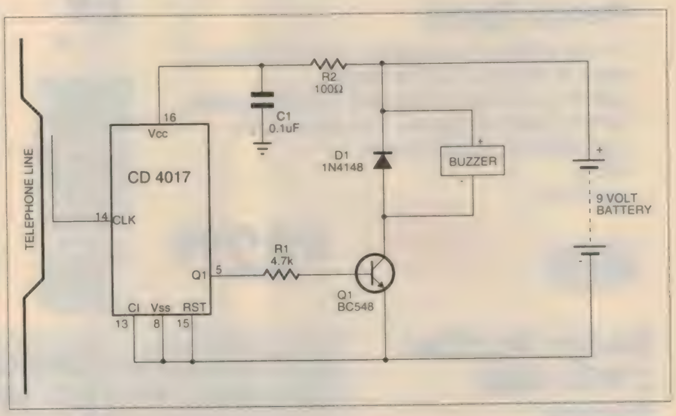
Auxiliary telephone ringer

Here's a handy telephone ringer that doesn't require any electrical connection to the telephone line. When the telephone rings, an AC voltage (usually 70 - 150VAC) with a frequency of 25Hz is present on the telephone line. By winding a short sense wire (approximately 100mm long) around the telephone line, the voltage produced can be enough to clock a 4017 decade counter, due to the high input impedance of the counter's clock input.

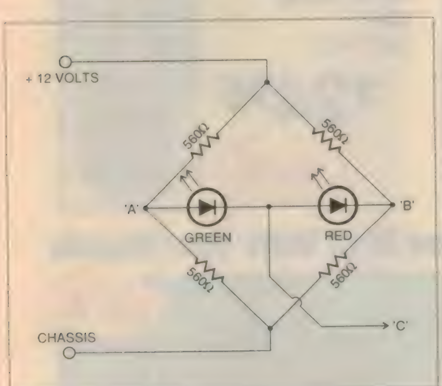
The decade counter divides this 25Hz signal by ten, producing a 2.5Hz square wave on its Q1 output. This is then used to drive the transistor, which in turn drives a small 9V buzzer. D1 prevents any back EMF from the buzzer from damaging the transistor, while R2 and C1 provide a small degree of line filtering, preventing false triggering of the counter. If you wish to remotely install the buzzer, extend the buzzer's leads, not the sense wire, otherwise the counter could trigger erroneously. The unit should therefore be mounted as closely as possible to the telephone line for reliable operation.

The circuit runs off a 9V battery, and needs no on/off switch, as the quiescent current of the 4017 is in the order of microamps.

Pradeep G
Alappuzha, India. **$30**



Polarity probe



Have you ever wondered if that wire in your car was connected to positive, negative, or not connected to anything? Well, here's a handy little device that will tell you. Bridges are useful in many applications, as in this one. When power is applied to the circuit, the points 'A' and 'B' will at the same voltage, and so no voltage will appear across either LED. When the probe touches a wire connected to either ground or a voltage source, the bridge will be unbalanced and the appropriate LED will turn on.

I mounted this circuit in a large highlighter pen case, with a needle at one end to probe through insulation, and a curly cord with battery clips at the other.

Albert King
Greenmount **$20** ❖

WIN OUR 'IDEA OF THE MONTH' PRIZE!

As an added incentive for readers to contribute interesting ideas to this column, the idea we judge most interesting and innovative each month now wins its contributor an exciting prize, in addition to the usual fee. The prize is a compact CCD video camera module from sponsor Allthings Sales & Services, offering 460 TVL resolution and 0.08 lux sensitivity, and valued at $199.00!

DICK SMITH ELECTRONICS

New And Exciting Products

CO Video/Audio Cleaner

Great for cleaning audio and video heads. Non-staining and non-corrosive. It can be used on all components with no effects on plastics, elastomers, painted or varnish based material.
150g
Cat N-1079

CRC NEW **$14.95**

CO Contact Cleaner

Safe formula harmless to most plastics. 100% free of CFC's. Evaporates rapidly and completly.
350g spray can. Flammable.
Cat N-1072

$19.95

CRC

Freeze Spray

A very efficient dry coolant that has many uses in the electronic/avionics, automotive/engineering and furnishing fields. Simply point and spray. Includes nozzle extention for smaller items.
500g.
Cat N-1077

CRC NEW **$32.95**

Airbrush

Safely removes dust and lint from all delicate precision equipment. Safe to use and non-corrosive or flammable. Leaves no residue or condensation.
500g.
Cat N-1078

NEW **$34.95**

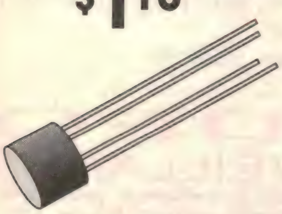
CRC

Bridge Rectifier 2W06 600V 2Amps

NEW

Cat Z-3308

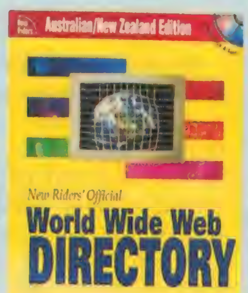
$1.10



Australia/New Zealand WWW Directory And CD 1996 Edition

The most comprehensive guide available to the services, information, and resources the World Wide Web has to offer. CD ROM contains electronic version.
Cat B-7061

NEW **$59.95**



Driver And 28 Bit Set

Consists of a strong driver handle with a magnetised tip, 28 various bits and a handy storage case.
Cat T-4503

$24.95

NEW

Assorted Audio Drive Belts

Comes in packs of 10.
Cat H-6015

$4.95

Assorted Video Drive Belts

Comes in packs of 14.
Cat H-6016

$9.95

NEW

Choose A Tool Box That Suits Your Needs

1. Tray Tool Box
290 X 130 X 110mm
Cat H-2593 **$8.65**

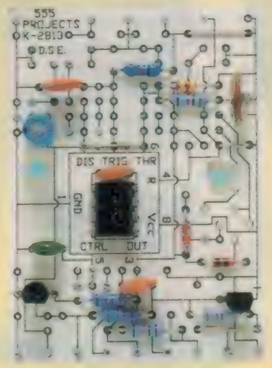
2. Tray Tool Box
325 X 170 X 155mm
Cat H-2594 **$16.95**

3. Tray Tool Box
390 X 195 X 195mm
Cat H-2595 **$24.85**

NEW

Kits, Kits, Kits!

DISCOVERY SERIES



Multi 555 Timer Circuits

A general purpose IC that acts as a building block for timer projects. The 555 allows a timer or pulse generator to be quickly and cheaply put together with just a few parts. It is also capable of operating relays directly, and is easier to set up for those utility projects. Supply voltage range is 4.5V to 16V. Supplied with all components & a silk screened, solder masked PCBs, and a comprehensive instruction manual showing many circuits & overlays for different timing configurations.

Cat K-2813

$16.95

EA Aug '96

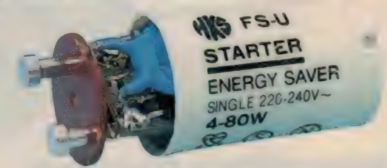
Electronic Fluoro Starter

For rapid turn-on and blink-free running of your 18 and 36W slimline fluorescent tubes, this is the kit. It fits in a standard starter case so the lamp wiring does not have to be altered. Also suitable for older style 20 and 40W tubes. Kit is supplied with all specified components, PCBs, and starter case. Due late August

Cat K-3012

$19.50

SILICON CHIP Aug '96



Sealed Lead Acid Battery Charger

Charge your 12V SLA batteries directly from your car or boat battery. Charges up to 2A to a 13.8V endpoint.

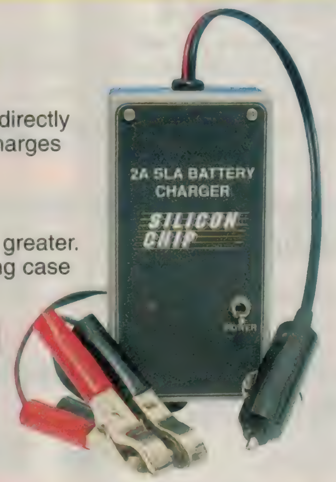
Features:

- 2A average current limit
- Suitable for 6.5AH capacity or greater. Kit supplied complete, including case and front panel label.

Cat K-3211

$49.50

SILICON CHIP Aug '96



3 Band Amateur Receiver

If you own a cheap short wave radio and are dissapointed with the reception you're receiving from amateur radio signals then this easy to build receiver is for you! You'll be able to listen in to SSB & CW signals on the three most popular HF amateur radio bands (80, 40, 20m). The kit is supplied in full form with all components, hardware, PCB, pre-punched front panel and case.

Cat K-6007

$99

SILICON CHIP Sept '96

Infrared Volume Controller

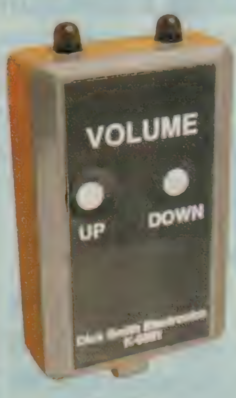
Controlling the volume on your K-5591 50W Amp kit is a breeze with this usefull and easily put together kit. The transmitter is powered from a single A23 12V battery. Kit is supplied with all components, PCB's, motorised volume pot & case for transmiter unit.

Cat K-5591

Battery optional - use 12V A23BPI (Cat S-3335)

$39.50

EA Sept '96



50W Stereo Amp

An amplifier offering unique features not normally found in everyday home stereo systems. Output power is to 50W RMS per channel into 8 ohm loads. Designed with a coupler socket & switch set up providing direct stereo patch point between pre-amp output & the power amplifier. Ideal for home theatre where additional power amps or subwoofer amps need to be used in parallel. Kit is supplied with all components, hardware, PCBs, pre-punched case and front panel.

Specifications:

Output

Single channel: 54W RMS
Both channels: 46W RMS

Input sensitivity

Power Amp: 1V RMS

Frequency Response

Power Amp Input: +0/-0.5dB 20Hz to 30kHz

Cat K-5590

EA Jul '96

$299

NOW AVAILABLE

Availability: Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store.

Construction project:

PC BUS SLEUTH

Having trouble with your new sound card? Is that internal modem *still* not talking to you? If so, this project is for you. Able to be used on any motherboard — from XTs to Pentiums — our PC Bus Sleuth card provides an easy way to home in on those frustrating IRQ and DMA conflicts that can make installing new hardware a nightmare.

by GRAHAM CATTLEY

The main philosophy behind the PC is that the motherboard comes with little or no peripheral support, relying on add-on cards to perform necessary functions. This allows major system components to be upgraded or replaced by simply plugging in a new card.

However, anyone who has tried to install new hardware in their PC has almost certainly run into problems with resource conflicts, usually involving the DMA and IRQ control lines. Conflicts arise because any single IRQ or DMA line can only be used by one device in your system.

If, for example, your mouse port (COM1) is configured to use IRQ 4, that IRQ must not be used by any other device in your system. If another device *does* try to use the same IRQ (an internal modem for example), you may find that the mouse 'dies' whenever you try to use the modem.

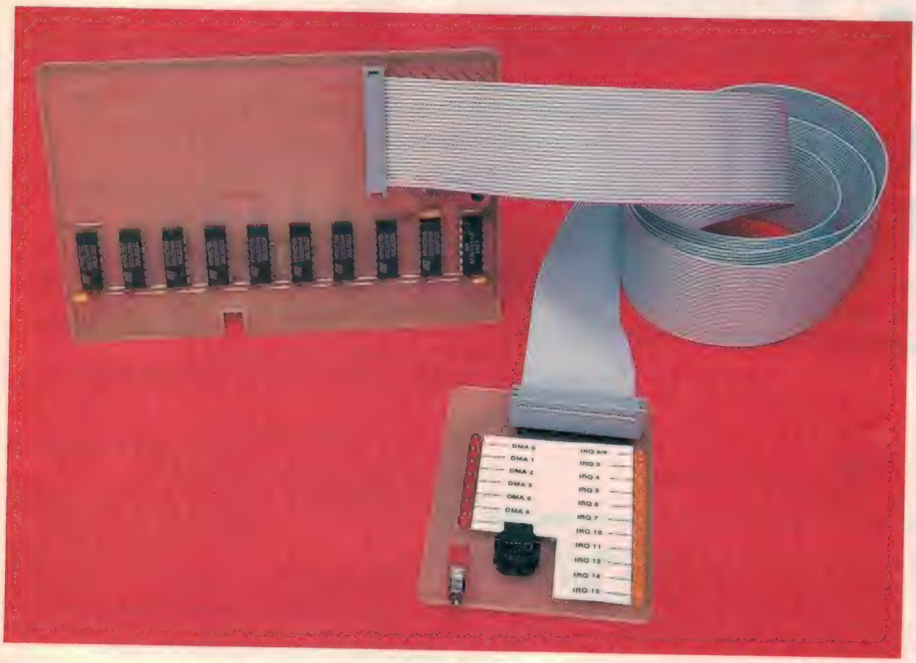
Sound familiar? A DMA/IRQ conflict is probably the single most common problem that users face when installing a new piece of hardware into a computer system. Confusingly, the conflict may not be immediately apparent — it is possible for two devices to share an IRQ or DMA line quite happily, with problems only surfacing when the two devices are used at the same time.

Conflicts can also manifest themselves in a number of different ways. For example, a newly installed sound card may seem to work correctly in some applications, but fail to work, or even crash the system in others. COM ports, which use two IRQs to service four potential serial ports are another traditional minefield, especially when installing serial devices such as internal modems.

In all such cases it is very difficult to determine just where the problem lies — were the device drivers for the new peripheral installed correctly? Does the application know how to talk to the device? A common error is to configure the device driver for one set of DMA and IRQ assignments, while the actual card is set to another. Unless you know the hardware settings for each and every card in your system, you'll have a difficult time just getting a handle on what's wrong.

Even if there aren't any conflicting IRQ/DMA assignments, you can still run into problems if the software drivers are configured for one IRQ while the card is set to another. The usual approach is to fix this problem empirically — trying different driver settings in the hopes that they will eventually match the settings on the card (usually crashing the system with each unsuccessful attempt). This situation usually comes about because the user has no idea as to the card's actual hardware settings.

There's a lot of diagnostic software around that claims to indicate which IRQs and DMAs are used in your machine, but the sad fact is that software *cannot* accurately determine which IRQs and DMAs are in use. Some packages will produce impressive tables of control lines and their respective devices, but these can only really be intelligent guesses, and are not necessarily true. (A good demonstration of this fact is to try running several of these types of programs — often they will each give you different results for each piece of hardware in your system.)

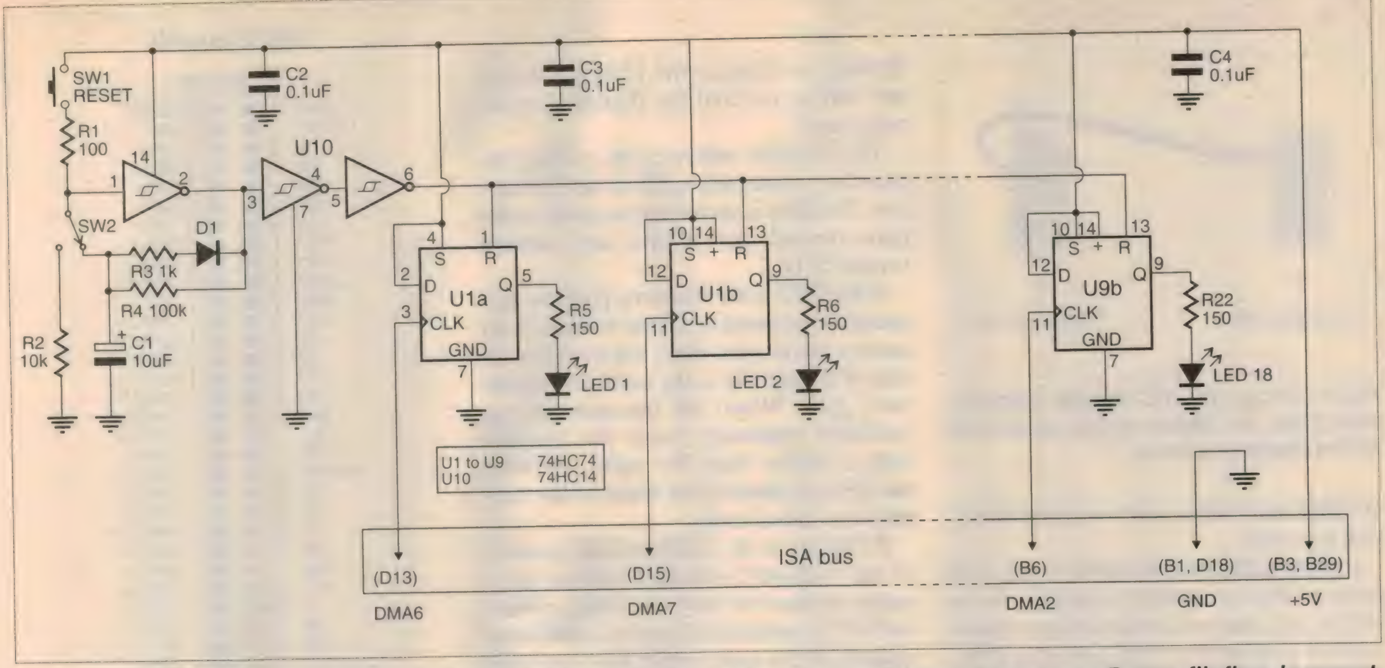


The Sleuth

The only real way to determine actual IRQ and DMA usage in your system is to physically monitor the lines on the motherboard itself. As the more perceptive among you may have already guessed, this is exactly what our new PC Bus Sleuth does.

When plugged into a vacant ISA slot on the motherboard, the Sleuth will indicate exactly which IRQ and DMA control lines are being used. An external board connected to the Sleuth via a length of ribbon cable allows you to monitor the activity on each of the control lines, through a display with 18 LEDs.

The Sleuth can operate in one of two modes: Realtime and Hold. In realtime mode, the LEDs light only while their respective control lines are asserted. Hold mode, on the other hand, will latch even the briefest flicker of activity on the control lines, effectively keeping a record of



The deceptively simple circuit diagram for the PC Bus Sleuth. The main circuit block, based on a D-type flipflop, is repeated a total of 18 times — one for each IRQ and DMA control line on the ISA bus.

About IRQs and DMAs

All PCs are limited by the fact that the CPU can only perform one function at a time. Unfortunately this isn't terribly useful, as we often want it to do a number of things at once — updating the screen, scanning the keyboard, talking to the disk drive, and calculating a spreadsheet for example.

The most effective way to organise all this activity is to use a system of *interrupts*: that is, to leave the processor to run the most important task, and interrupt it when another task needs to be performed. For example, you could be running a program that requires input from the keyboard. If the computer were to sit there all day waiting for the user to press a key, it obviously couldn't be doing anything else. With an interrupt based system, however, the keyboard generates an interrupt whenever a key is pressed (via IRQ 1, from the keyboard controller), which causes the processor to stop whatever it is that it is doing, and go and process the data from the keyboard. In this way many tasks can be performed, seemingly at once.

Interrupts are generated by hardware devices whenever they need attention from the CPU. Each device needs to be assigned its own interrupt request (IRQ) line, so that the CPU knows which device interrupted it.

Problems arise when the same IRQ is assigned to more than one device, as the CPU can't tell which one needs servicing. In this situation, the CPU may service one device (whether it needs it or not), while ignoring the other completely, or even ignore both of them altogether.

DMAs perform a completely different function in the PC. They are used to allow a hardware device direct access to the computer's system memory, without having to go through the CPU and its associated I/O ports. This allows the device fast, direct access to data stored in memory, without any of the CPU's timing overheads. When a DMA line is asserted, a dedicated processor known as a DMA controller blocks the CPU from the system bus and takes over the transfer of data between memory and the device.

Hard and floppy drives originally made extensive use of direct memory access (DMA), as it allowed them to transfer large amounts of data at a rate far in excess of the 4MHz clock speed of the CPU in the first PCs. With the advent of high speed motherboards (33, 50 and 66MHz), however, the use of DMAs for hard and floppy drives has now become somewhat redundant (although you may find that a DMA channel is still allocated for floppy drives).

The primary use for DMAs these days is for sound cards. These often use two DMA channels (one 8-bit and one 16-bit) for high speed wave data transfer. As DMAs are used by few devices in the system (usually only the floppy controller and sound card), DMA conflicts are less common than IRQ conflicts, but are just as disabling when they do occur.

Common IRQ assignments

(AT bus)

IRQ no	Assigned device
IRQ 0	System Timer
IRQ 1	Keyboard controller
IRQ 2	(Used by second IRQ controller for IRQ 8-15)
IRQ 3	Serial port COM2: or COM4:
IRQ 4	Serial port COM1: or COM3:
IRQ 5	Sound card/Parallel port LPT2:
IRQ 6	Floppy disk controller
IRQ 7	Parallel port LPT1:
IRQ 8	Real time clock
IRQ 9	Available, appears as IRQ 2 on 16 bit slot
IRQ 10	Available/Network adapter
IRQ 11	Available
IRQ 12	Available/Motherboard mouse port
IRQ 13	Maths co-processor
IRQ 14	Primary IDE hard disk controller
IRQ 15	Available/Secondary IDE controller

Common DMA assignments

(AT bus)

DMA no	Assigned device
DMA 0	Available/DRAM memory refresh on XT (8-bit)
DMA 1	Sound card/Available (8-bit)
DMA 2	Floppy disk controller (8-bit)
DMA 3	Available (16 bit)
DMA 4	(Used by second DMA controller for DMA 0-3)
DMA 5	Sound card/Available (16 bit)
DMA 6	Available (16 bit)
DMA 7	Available (16 bit)

PC Bus Sleuth

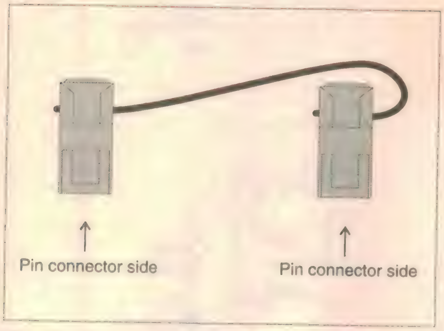


Fig.2: Crimp the IDC header connectors onto the ribbon cable as shown in the diagram above.

all IRQs and DMAs used since the Sleuth was last reset.

Using the Sleuth is simplicity itself, as it needs no driver software or jumpers to set on the card, and will work with any motherboard with an ISA slot. Just plug it in, and within a couple of minutes you'll be well on your way to tracking down the source of your system's resource conflicts.

The circuit

As mentioned earlier, this circuit monitors all 18 of the control lines available from the ISA slot — it's essentially 18 logic probes on a card, each looking at the logic state of a single DMA or IRQ line.

Each 'probe' consists of one half of a 74HC74 dual D-type flipflop, which clocks every time that particular DMA/IRQ input is used. When clocked, the flipflop transfers the logic high on its D input through to its Q output. This lights the corresponding LED, indicating that the monitored control line was used by the system. Repeated use of a control line doesn't affect the output status of the flipflop, resulting in the LED turning on and staying on until the flipflop is externally reset.

The flipflops are reset by pulling the reset line connected to all of the flipflops low. This line is driven by the small oscillator formed around the hex Schmitt inverter U10.

With SW2 in the Realtime position, this oscillator produces a square wave with an uneven mark-space ratio, due to the inclusion of R3 and D1 in the oscillator's feedback path. When left free-running, the oscillator repeatedly resets the flipflops with a narrow logic low pulse, allowing the LEDs to display the status of the control lines in real time.

If SW2 is in the Hold position, however, the oscillator is disabled and the pin 4 output swings low only when the pushbutton SW1 is pressed. R2 acts as a pull down resistor in this case, while the low value resistor R1 serves to limit the capacitor discharge current if SW1 happens to be pressed while the oscillator is running. (It is important to note that pressing the Sleuth's reset button doesn't reset the *computer* — its only function is to extinguish the LEDs.)

The supply of +5V is fed to the circuit by pins B3 and B29 in the ISA slot, and is decoupled by monolithic supply bypass capacitors C2, C3 and C4. You'll note that the positive supply is taken only from the 8-bit section of the card — this means that the card will be powered no matter what size ISA slot it is plugged into.

Construction

As you can see from the lead photo, the Sleuth consists of two PC boards, joined by a length of 26-way ribbon cable. Before

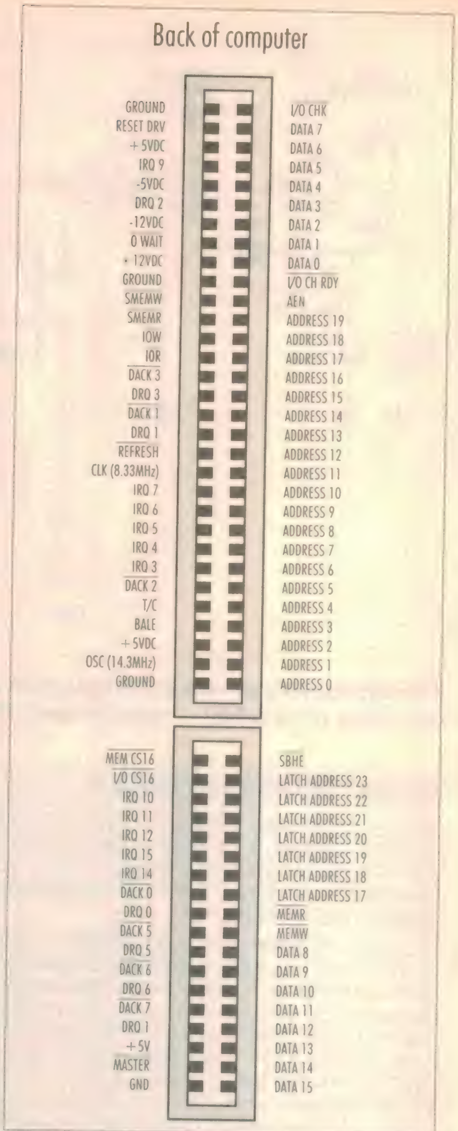
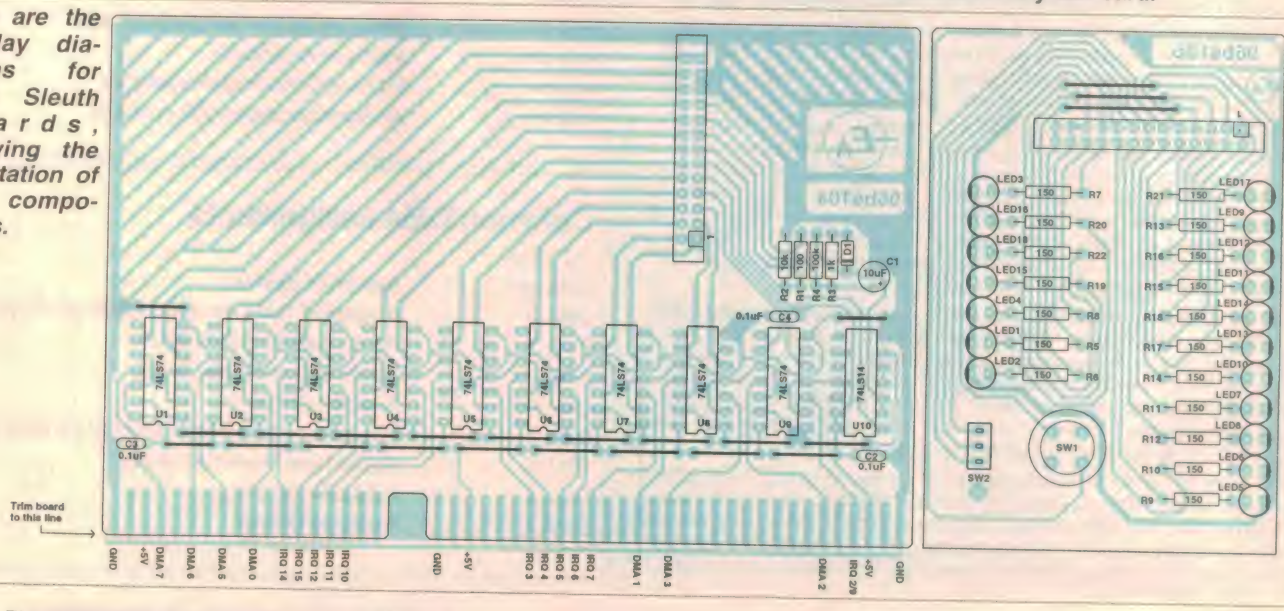


Fig.1: The ISA bus pin connections. This diagram is printed actual size, so you can use it to determine the connections on any ISA card.

Here are the overlay diagrams for both Sleuth boards, showing the orientation of all components.



starting construction, carefully examine both boards for any defects in manufacture, as there are quite a few tracks that run between pins on the ICs, and these can sometimes etch through or short to an adjacent IC pin.

If you are making your own PC boards, you will need to ensure that you trim off the track that joins all of the contacting fingers along the bottom edge of the larger board. The purpose of this track is to electrically connect all of the edge contacts together to facilitate having them gold plated — gold plating avoids the problem of copper oxide accumulating on the edge connector, and makes for a reliable connection every time.

If you plan to use the Sleuth on a regular basis, I would strongly advise that you do get these contacts plated — the cost will be relatively low and the benefits will last the lifetime of the board.

The larger board should be trimmed to 134mm (5-1/4") wide, and have a 6 x 8mm notch cut in it so that it will fit into a 16-bit (AT) ISA slot. A bit of work with a file or nibbling tool will make short work of these requirements, and if you are feeling ambitious, you can round the corners and chamfer the edge of the card so that it slots into the connector easily.

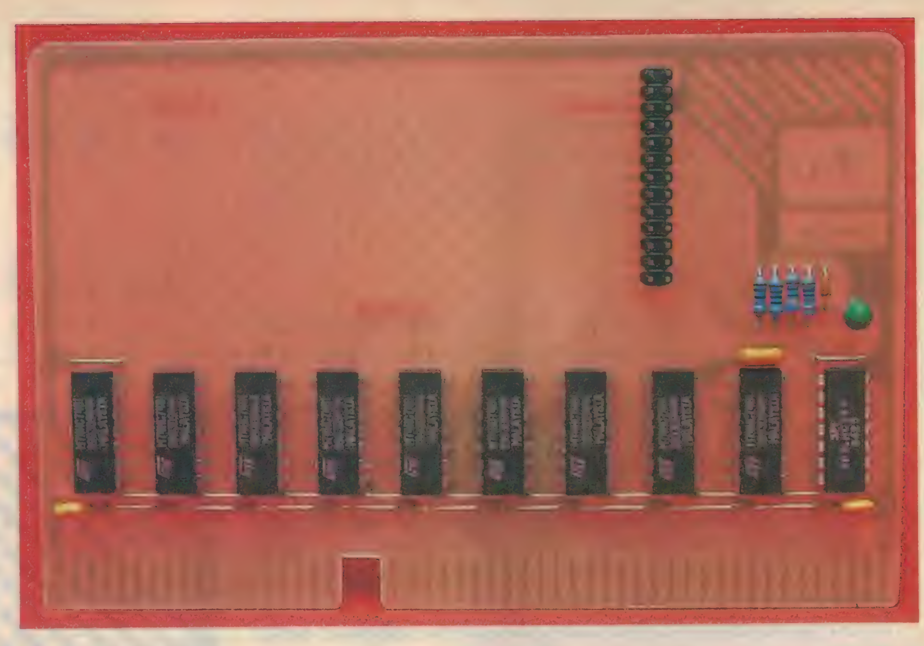
Once you have finished with the more mechanical aspects of this project, you can start construction by installing the 20 links on the larger board. These can be followed by the diode, four resistors and the four capacitors. Check with the overlay diagram to verify the orientation of D1 and the 4.7uF capacitor.

Snap off a 26-pin length of header strip, and solder it into the board, and you'll only have the ICs to go. All of the ICs are mounted with pin 1 facing towards the edge connector, with the 74HC14 (IC10) mounted on the extreme right hand side of the board. Although these HC series ICs incorporate input protection diodes, it is best to observe the usual anti-static precautions when soldering them into the board — although once installed, they are quite robust.

Display board

That completes the construction of the larger interface board, leaving only the smaller display board to be built. Start by installing the three wire links, followed by the eighteen 150Ω resistors. The LEDs are next — the seven on the left (DMA) have their cathodes facing left, while the 11 on the right (IRQ) are mounted with their cathodes on the right.

Another 26-pin length of header strip can now be soldered in, along with the pushbutton and miniature toggle switch.



The above close-up shot shows how the larger interface board is trimmed, so that it can be inserted into an ISA slot on the motherboard, while below is the smaller display board with a mini PCB mount toggle switch used to set the display mode.

An extra pad on the PCB near SW2 allows a mini right-angle PCB mount toggle switch to be used, with the pad accommodating the switch's mounting lug. If you don't have a PC mount switch, you can use a standard mini toggle and mount the switch on its side, using short lengths of tinned copper wire to connect it to the board.

While the smaller display board was intended to be left bare, there is no reason why you couldn't mount it inside a small plastic box with the LEDs and switches protruding through suitable holes drilled in the lid. Either way, the small front panel should be affixed so that you can identify the LEDs — in the case of the bare board, this can be a thin piece of card glued to the tops of the resistors, as shown in the photo.

The two boards are joined together with a suitable length of 26-way IDC ribbon cable. To make this, crimp a 26-way header to each end of the cable, using a vice or large pair of pliers if you aren't lucky enough to have the proper crimping tool. If your cable has a coloured stripe along one edge of the cable, make sure that it goes to pin 1 on each connector.

Attach the connectors so that the cable leaves them in the same direction (see Fig.2). When fitted to the boards the cable will then exit the larger interface board from the right hand side, and enter

PARTS LIST

Resistors

(All 5% 0.25W)

R1	100 ohms
R2	10k
R3	1k
R4	100k
R5-R22	150 ohms

Capacitors

C1	4.7uF 16V tantalum or electro
C2-C3	0.1uF monolithic bypass

Semiconductors

D1	1N4148 signal diode
LED1-4,15,16,18	Red 3mm LEDs
LED5-14,17	Yellow 3mm LEDs
U1-9	74HC74 dual D-type flipflop
U10	74HC14 hex Schmitt inverter

Miscellaneous

2 x PCBs 134 x 87mm and 60 x 87mm, coded 96bs10a and 96bs10b; PCB mount SPST pushbutton; ultra mini SPDT toggle switch (R/A PCB mount preferred); 2 x 26-way DIL header pin strips; 2 x 26-way DIL IDC header connectors; 1m x 26-way IDC ribbon cable; Tinned copper wire for links.

the smaller display board from the top. If you snip off pin 26 of both header pin strips, and block the corresponding hole in each of the connectors, you can prevent the cable from being accidentally inserted backwards when the two boards are joined together.

Testing

Before using the card for the first time, carefully examine your soldering on both boards, looking for solder splashes or shorted tracks. Problems here could cause unpredictable results in the computer's operation.

Once you are happy with the two boards, connect them together with the ribbon cable (ensuring pin 1 on the cable joins to pin 1 on the boards), and plug the interface card into an 8 or 16-bit ISA slot in your computer. Switch the computer on, and with any luck, you will see some activity on the LEDs. Depending on the setting of SW2, various LEDs will either flash on and off, or turn on and stay on as the computer boots up.

If you get no response from the LEDs, or the computer seems to be behaving strangely, switch off the computer and remove the Sleuth from the motherboard. Switch the computer back on to verify that the problem is in the Sleuth card and not in the computer. Ensure that the ribbon cable is connected correctly — check with the component overlay diagram for the location of pin 1 on both the interface and display boards.

Another potential source of trouble is the edge connector itself. With the computer switched off, plug the Sleuth back into an ISA slot, and take a good look to see if the contacts in the slot align with the fingers on the PC board. If you have cut the PC board too small, it could move out of alignment, shorting some of the contacts together.

Resolving conflicts

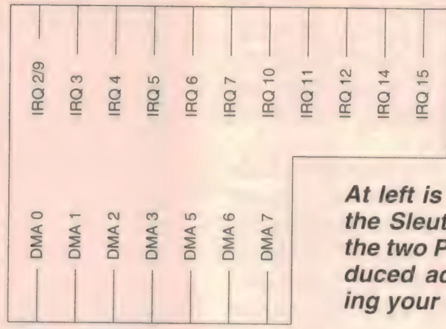
All being well though, you should find that the computer boots up normally, and that a couple of LEDs were active during the boot procedure. If you keep the SW2 in the Hold position, you'll be able to see that at least two IRQ lines are asserted during boot up — one for the hard disk (probably IRQ 14), and one for the floppy (IRQ 6).

If you have loaded a serial mouse driver, you should find that moving the mouse will cause the IRQ3 or IRQ4 LED to turn on. Note that this LED turns on only after the mouse is first used. This is because an IRQ assigned to a device is not used until the device actually needs it. This highlights the point that an IRQ or DMA may *appear* to be free, when in fact it just hasn't been used yet...

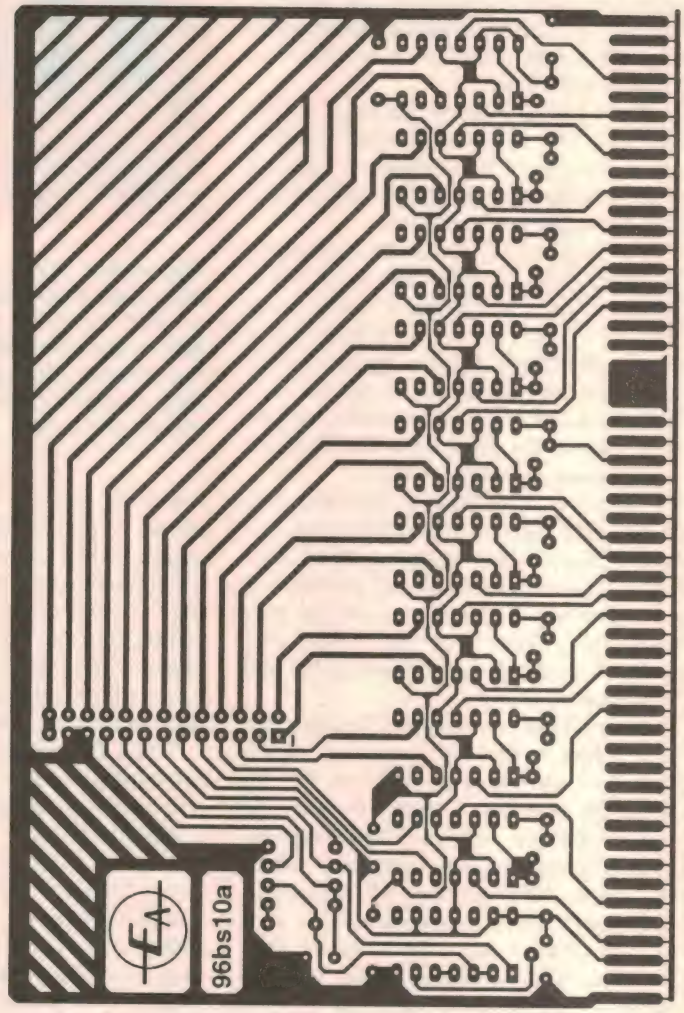
The first step in resolving conflicts is to determine the hardware settings for each device in the system. This can be accomplished by the following procedure:

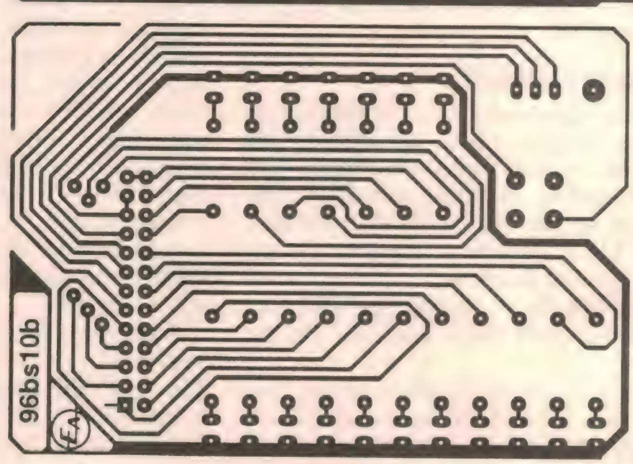
1. Remove all cards from the system, leaving only the video and hard/floppy controller cards, if present.
2. Insert the Sleuth (with the switch in the Hold position) into a vacant ISA slot and turn on the computer. You may need to reset the Sleuth immediately after power up, to clear the LEDs.
3. Note any IRQ/DMA LEDs that turn on during the boot procedure, and then switch off the computer.
4. Insert one of the cards that you removed, reboot the computer, and attempt to use the card. (i.e., for a sound card, try playing a .WAV file, MIDI song, and possibly a game that uses the sound card.)
5. Note down any additional LEDs that turn on as the card is used.

(Continued on page 101)



At left is the front panel for the Sleuth, while below are the two PCB patterns reproduced actual size for making your own boards.





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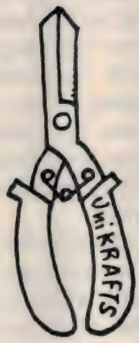

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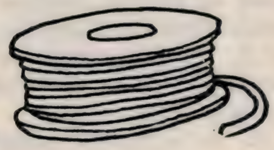

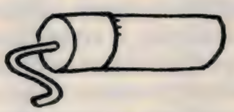

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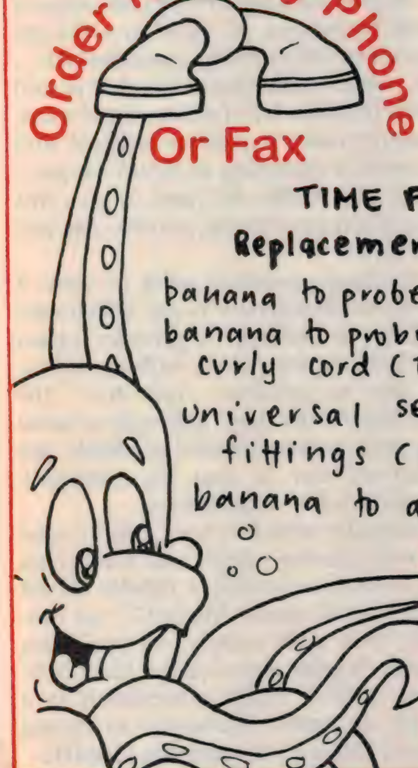

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READER INFO NO. 53

Construction Project:

SIMPLE 10/20MHZ 'COMB' GENERATOR

Here's a low cost, easy to build little unit which generates a signal that is very handy for calibrating spectrum analysers and other instruments. It produces a train of narrow pulses, corresponding to a set of signals at 10MHz, 20MHz and their combined harmonics — extending up to 150MHz and beyond.

by JIM ROWE

In many ways, this little project is yet another 'accessory' for the Low Cost VHF/UHF Spectrum Analyser design I presented in the September/October 1992 issues, like the Wideband Noise Source of August 1994 and the Wideband Upconverter described last month. It was while developing and testing the original Analyser that I first realised there was a need for something like it, and this realisation was reinforced recently during development of the Upconverter.

The fact is that like many other low cost 'home brew' spectrum analysers, the 1992 design uses a free-running first RF oscillator, and as a result its frequency axis is essentially uncalibrated. So in order to find the actual frequency of a signal 'blip' visible on the sweep, you really need to compare it with a known-frequency reference signal.

For those with an RF signal generator or other calibrated RF source, this isn't a serious problem. You simply fire up the generator and use it to set up the Analyser so that it's sweeping over the freqyency range you're interested in. You can even leave the generator running, if you wish, and feed its output into the Analyser along with the signals you want to examine (via a simple mixing system), so that it can be used as a 'marker'.

But what if you don't *have* an RF generator, or don't want to tie it up as a marker generator? That's where a simple comb generator can come in very handy, providing a source of convenient reference signals, of known frequency.

Basically a comb generator is just a crystal oscillator operating at a suitable accurate frequency, and arranged so that it produces an output that is very 'rich' in harmonics. The oscillator output and its harmonics then form a 'comb' of accurately spaced signals extending up the spectrum, with each signal component corresponding to a 'tooth' of the comb.

With very little circuitry, the Comb Generator fits in a very small aluminium utility box. As it's typically only used for a few seconds at a time, the power switch is a pushbutton.

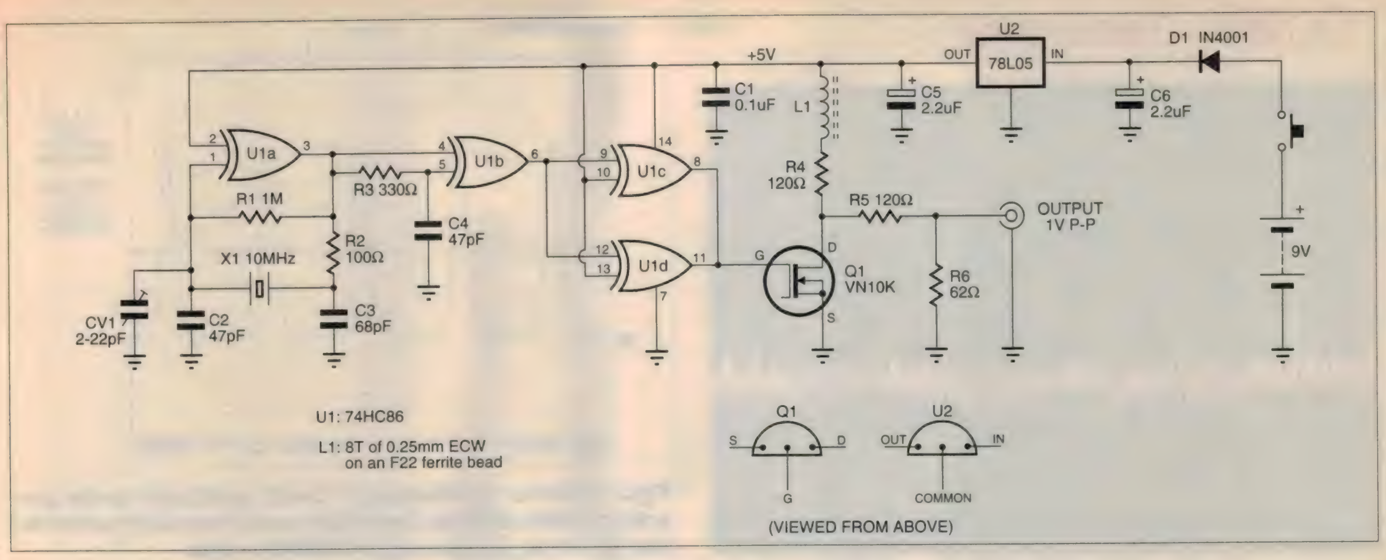
Does this mean just a crystal oscillator producing a squarewave signal, to get plenty of harmonics? Not quite. A squarewave certainly tends to be rich in harmonics, but if the waveform is a perfect squarewave then its harmonics are all odd-ordered (3rd, 5th, 7th, 9th etc). There will be no even-ordered harmonics (2nd, 4th, 6th, 8th etc) — so our frequency comb will be missing every alternate 'tooth'.

To produce a signal with both odd *and* even harmonics, we need to make the waveform deliberately asymmetrical — i.e., with a mark-space ratio that is well away from the 1:1 of a pure squarewave. And of course to produce a signal with harmonics extending as far up the spectrum as possible, we need to give this waveform the shortest possible rise and fall times.

So from a practical point of view, a good comb generator is one which uses the crystal oscillator to generate a train of fairly narrow pulses, with transitions as fast as possible. And that's the approach taken here, although as usual the need to keep the design simple and relatively low in cost has inevitably involved a few compromises.

Basically what I've been able to come up with is a very simple unit which uses only two low-cost ICs, a 10MHz crystal and a small power MOSFET, all running from a 9V battery. As you'll see shortly, it generates a train of short pulses at 20MHz, which corresponds to a comb of useful harmonics extending from 10MHz up to well past 150MHz.

This makes it very handy for use with the Spectrum Analyser — either alone, or with the LF Upconverter — as well as for use in calibrating other instruments like scopes and (possibly) fre-



Above is the schematic for the generator, which uses only two ICs and a small power MOSFET. Fig.1 (right) shows how the R3/C4 delay circuit is used with U1b, to generate narrow 20MHz pulses.

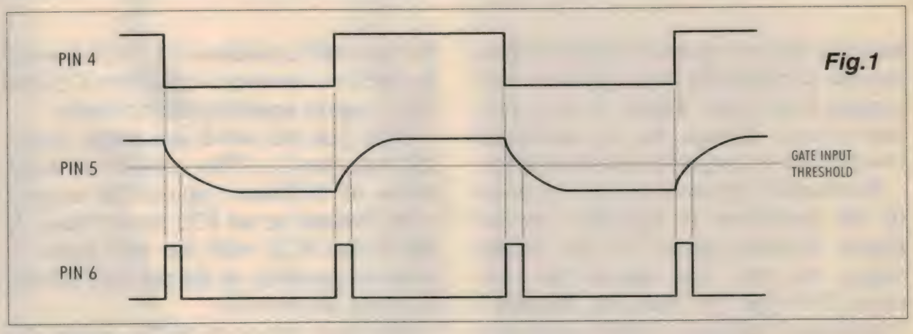


Fig.1

quency counters. With a suitable RF attenuator you could even use it to check the calibration of shortwave and communications receivers.

Circuit description

As you can see from the schematic, there's not a lot in it. One of the gates in a 74HC86 quad XOR IC (U1a) is used in a standard crystal oscillator, with 10MHz crystal X1. Resistor R1 provides the bias to achieve quasi-linear operation, while R2 and C3 provide a low-pass filter to ensure that the crystal operates on its fundamental rather than an overtone. Capacitor C2 and trimmer CV1 allow the oscillator to be set to exactly 10MHz.

The output from U1a is very close to a symmetrical 10MHz squarewave, of course, but now comes the reason why we're using a 74HC86 quad XOR device rather than a 74HC00 or similar. Our 10MHz signal is now fed to both inputs of U1b — in one case directly (pin 4), and in the other via the delay circuit formed by R3 and C4 (pin 5). And since an XOR gate only produces an output when its two outputs are at *different* logic levels, this produces an interesting effect.

As shown in Fig.1, the only times that the two input signals of U1b *differ* are immediately following each transition of the 10MHz squarewave, when the transition hasn't effectively 'passed through' the RC delay to the second input. As a result what we get from U1ba is a string of short pulses, with a repetition rate of 20MHz and a width roughly corresponding to the delay instroduced by R3 and C4.

Note that in one fell swoop, we've effectively doubled our crystal-locked frequency to 20MHz, and also produced relatively narrow pulses with a mark-space ratio of much less than 1:1. Not bad for a 'cheap trick', wouldn't you say?

So we now have a suitable comb signal waveform, even though its transitions are not especially fast and it's at a relatively high impedance level — not really suitable for feeding into low impedance attenuators, mixers or other equipment. Hence the remaining circuitry, to 'sharpen up' the waveform and make it rather more robust.

As you can see, the two remaining gates of U1 are used in parallel as inverting buffers, to drive the gate of a small VN10K power MOSFET, Q1. As a result our narrow 20MHz pulses are used to turn Q1 on and off rapidly, reproducing the pulses at Q1's drain — at an impedance of only about 70Ω. And since Q1 can switch quite rapidly (4ns or less), our waveform is now fairly 'sharp'.

The output switching speed (and hence the harmonic content) is boosted by means of RF peaking choke L1, connected in series with Q1's load resistor R4. L1 is easily made by winding eight turns of wire on a small bead of F22 ferrite material.

Resistors R5 and R6 form a voltage divider, in conjunction with R4, giving a final output level of 1V p-p and an output impedance of very close to 50Ω.

Voltage regulator U2 is used to stabilise the supply voltage for U1 and Q1,

PARTS LIST

Resistors

All 1/4W 1% metal film:

R1	1M
R2	100 ohms
R3	330 ohms
R4,5	120 ohms
R6	62 ohms

Capacitors

C1	0.1uF monolithic
C2,4	47pF NPO ceramic
C3	68pF NPO ceramic
C5,6	2.2uF 16VW solid tantalum
CV1	2-22pF trimmer, PCB mount

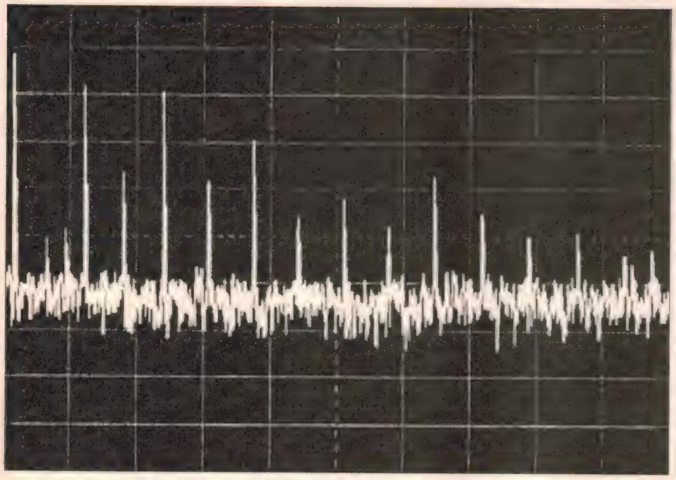
Semiconductors

D1	1N4001 or similar
Q1	VN10K power MOSFET, TO-92
U1	74HC86 quad XOR gate
U2	78L05 low power 5V regulator

Miscellaneous

10MHz crystal, HC-49/U; printed circuit board 51 x 76mm, code 96cg10; metal utility box, 100 x 60 x 45mm; 4 x 15mm insulated mounting pillars; BNC socket, uninsulated single-hole panel mount; momentary contact SPST pushbutton switch; 6-cell AAA battery holder (or 4-cell and 2-cell holders); 4 x rubber feet; hookup wire, solder, etc.

'COMB' Generator



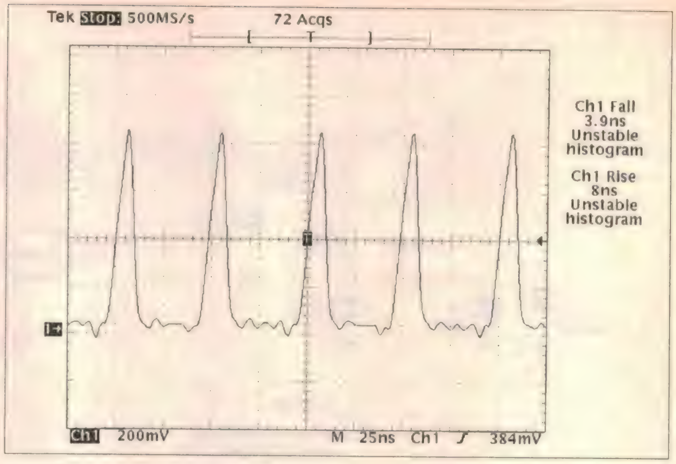


Fig.2: At left is the frequency 'Comb' produced by the generator, while above is the actual output waveform when fed into 50 ohms, as seen on a 100MHz scope.

ensuring that the generator performance remains substantially constant over a reasonable battery life. Diode D1 is to prevent circuit damage due to accidental reversepolarity connection of the battery.

Incidentally, because the current drain of the generator is typically around 60mA (mainly drawn by the output stage), we can't use one of the very small 216-type 9V batteries. Instead I recommend using six 'AAA' cells, in a suitable holder. However since the generator's comb signal is often only needed for short periods, I suggest that you fit it with a power switch of the momentary-contact pushbutton type, rather than the usual toggle or rocker type.

Construction

All of the comb filter circuitry fits on a very small PC board, apart from the pushbutton power switch, 9V battery and BNC output socket. The PCB measures 51 x 39mm, and fits comfortably inside the smallest readily available aluminium utility box (100 x 60 x 45mm), along with the battery holders. The PCB is mounted inside the box using four insulated spacers, 15mm long.

The etching pattern for the PCB is reproduced here, for those who like to make their own. Also shown is the overlay diagram, showing where everything goes on the PCB.

As usual it's best to check the PCB pattern before you fit any of the components, to make sure there aren't any bridges or hairline cracks. Then fit the four PCB terminal pins, used to facilitate the off-board connections — two for the DC power input, and two for the RF output.

It's then easier to fit the low-profile resistors first, followed by diode D1 (making sure that you fit it with the correct orientation) and trimcap CV1. Then fit the small capacitors C1 - 4, followed by the two tantalum capacitors C5 and C6 — again watching their polarity.

Now you can wind and fit the peaking inductor L1. This consists of eight turns of 0.25mm enamelled copper wire, wound on an F22 ferrite bead. It fits to the PCB with the wire leads as short as possible, in the position shown between R4 and C1.

The final step is to fit the crystal X1 (with its body as close as possible to the PCB), regulator U2, the quad XOR chip U1 and the power MOSFET Q1. Take care with the orientation of all three of these semiconductors, as they can be damaged if wrongly fitted.

Your PCB should now be complete, and ready to fit inside the box. As you can see from the internal photo, the PCB assembly, pushbutton switch and BNC connector all mount in the 'outer' half of the box, for simplicity. The BNC socket mounts in the centre of one end, while the PCB effectively 'hangs' underneath the top front panel with the switch at the far end of the panel, again centred.

I've prepared a small artwork for the front panel, even though the Comb Generator probably doesn't need one. You can use it to make a self-adhesive front panel from Dynamark, or at least use a photocopy as a template for drilling the switch and PCB mounting holes in the front panel.

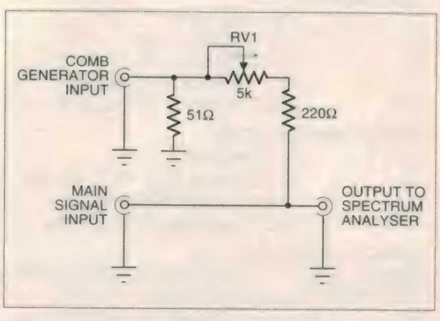


Fig.3: The small mixing circuit used by the author to allow the 'Comb' Generator's output (or that of a signal generator) to be added to the Spectrum Analyser's input signal.

Note that the reason for fitting the pushbutton switch at the far end of the panel is that this allows the battery holder(s) to be located conveniently inside, between the switch body and the PCB assembly. I couldn't procure a 6-AAA-cell battery holder for the prototype, so I used a 4-cell holder and a 2-cell holder and taped them together.

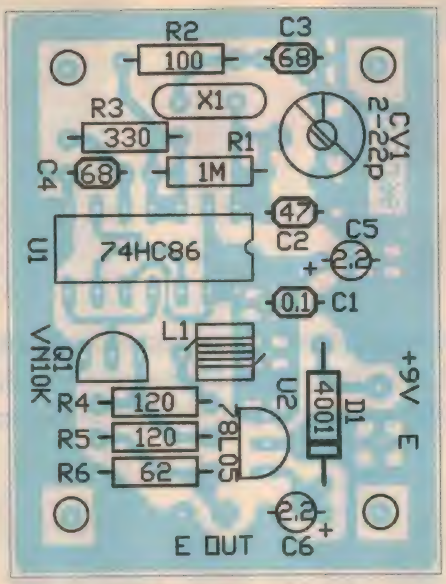
Fitting everything inside the box and completing the assembly should be quite straightforward, if you use the internal photo as a guide. The BNC output socket connects directly to the RF output pins on the end of the PCB, while the battery holder connections are connected to the power supply pins on the side, with the pushbutton switch in series with the positive lead.

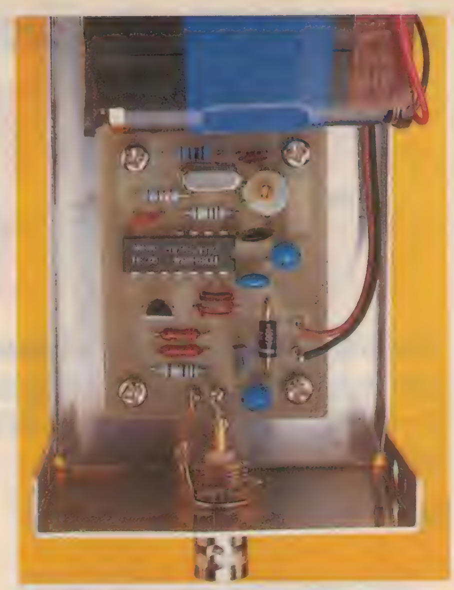
Testing & adjustment

As the Comb Generator is so simple, there's very little to go wrong and it should work correctly as soon as you've finished the assembly.

A quick check of basic operation would be to use your DMM (set to a suitable voltage range) to measure the DC voltage at pin 14 of U1, with the pushbutton switch pressed. The DMM's negative lead can be clipped to the earthy side of the BNC socket, for convenience. You should get a reading of very close to 5.0V, when the button is pressed; if not, switch off immediately and check both your off-board wiring — and also perhaps the orientation of D1 and U2, on the PCB.

Here is the PCB overlay diagram, and also an interior view showing where everything goes inside the box.





If the DC voltage measures OK, though, your unit is probably working correctly. Connecting the RF output to a wideband scope (100MHz or better) should show a waveform very similar to that shown in Fig.2, and connecting it to a spectrum analyser should reveal the expected 'comb' of frequencies, extending from 10MHz up to beyond 150MHz on multiples of 10MHz.

Note that the various frequency components aren't all of constant amplitude. The 10MHz and other 'odd order' components all tend to be of lower amplitude than the 20MHz and other 'even order' components, due to the mark-space ratio of the waveform. In practice this doesn't cause any problems, though — if anything, it helps you work out which is which. There's also a bit of variation in all of them over the spectrum, due to the way that the output circuit peaking works.

There's only one adjustment to make on the Comb Generator, and even that is optional: adjusting trimcap CV1 to set the crystal oscillator to exactly 10MHz. For most purposes the oscillator will be 'close enough' if you set CV1 to its mid position (i.e., plates half engaged), although if you have a suitable counter you may wish to set it more accurately. (Of course your counter will need to have an accurate timebase for this — such as the signal from our TV-Derived Frequency Reference.)

As many counters won't be too happy with the Comb Generator's narrow output pulses, you may need to measure the 10MHz squarewave output instead. To minimise loading effects, it may be best to connect the counter input to the output of U1b (pin 6), and temporarily disable the frequency doubling action of U1b by lifting on end of resistor R3, and connecting it temporarily to the +5V rail. U1b will then behave as an inverting buffer.

All you have to do then is adjust CV1 until the counter reading is as close as possible to 10.000MHz. If the trimmer range doesn't quite let you achieve this, you may need to change the value of ceramic capacitor C2.

Once the adjustment is made, don't forget to disconnect the free end of R3 from the +5V rail, and refit the resistor to the PCB. Your little Comb Generator should then be ready for use.

Using it

Putting the Generator to use should be fairly intuitive, since it simply produces a set of reference signals on multiples of 10MHz. The main thing to sort out is a convenient way to feed these signals into your spectrum analyser system, along with the signals you're really interested in.

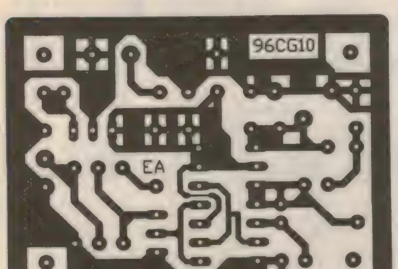
Often the most straightforward way is to use a small mixing box wired up along the lines of Fig.3. Here the idea is that your main signals pass 'straight through', while pot RV1 allows a small and adjustable amount of the Comb Generator's output to be added in, when desired (simply by pressing the Generator's pushbutton).

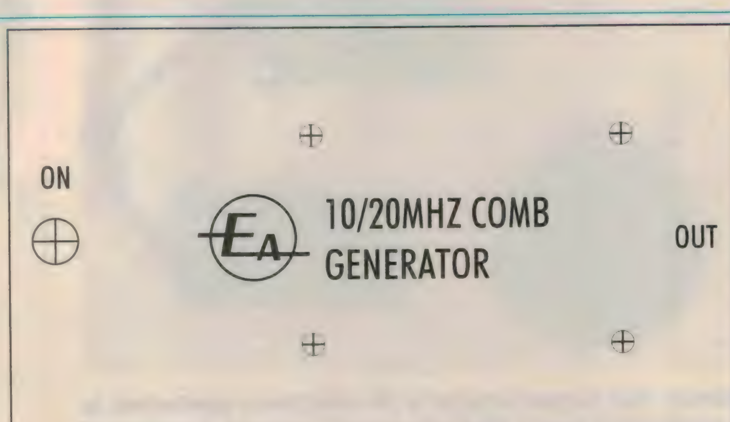
As the Generator's output is 1V p-p into an open circuit, or 0.5V p-p into 50Ω, its output level generally needs to be attenuated to prevent overloading the input of the Spectrum Analyser. The combination of RV1 and the fixed 220Ω resistor allows the attenuation to be adjusted over a fairly wide range (20 - 46dB, roughly), which should cover most applications.

I built this little mixing circuit into another small metal utility box, and it has also proved very useful. I decided to keep it separate from the Comb Generator, though, because this allows it to be used to mix in signals from a signal generator instead...

Hopefully you'll find both of these units as handy as I've done. ❖

And here's the artwork for both the PCB and front panel, as usual shown actual size for those who like to make their own.





Construction Project:

AN ELECTRONIC 'MUSIC BOX'

This little project is the electronic equivalent of a mechanical music box. It has a range of tunes, and is activated by light falling on a sensor fitted to the printed circuit board. Use it in a music box, a musical jewellery case, or fit it to anything that will be enhanced by adding music. It's easy to build, and runs off batteries.

by PETER PHILLIPS

This project, from Oatley Electronics, is one that will allow you to combine the hobbies of electronics and craft making. The electronics is provided by the project itself, which as the photo shows is a small printed circuit board assembly, a speaker and a battery clip. The craft component is anything you want to build, to which it can be added to provide music...

A typical choice is a jewellery box, in which opening the lid makes the music play. Or you might fit it to a box covered with decoupage, where the box is an ornament, but with the added feature of producing music when it's opened.

Other possibilities include a rotating doll stand, automata, a music box, a musical picture and so on. So we could really call this project a music 'engine', rather like a little mechanical music box movement.

The operating principle is very simple: when light falls on the sensor (a light dependent resistor) fitted to the printed circuit board, the music starts. When the light is removed (e.g., by closing the lid of a music box), the music stops. The circuit board measures 50 by 40mm, and connects to a small 8Ω speaker. The circuit is powered by two AAA-size 1.5V cells fitted to a battery clip. So the whole thing is quite compact, and needs no mechanical links to operate it.

In its quiescent state the circuit takes around 50uA from the batteries, and about 20mA when operating. So there's no need for an on-off switch. The volume and sound from the unit is comparable to a reasonable quality mechanical music box, depending on your choice of speaker.

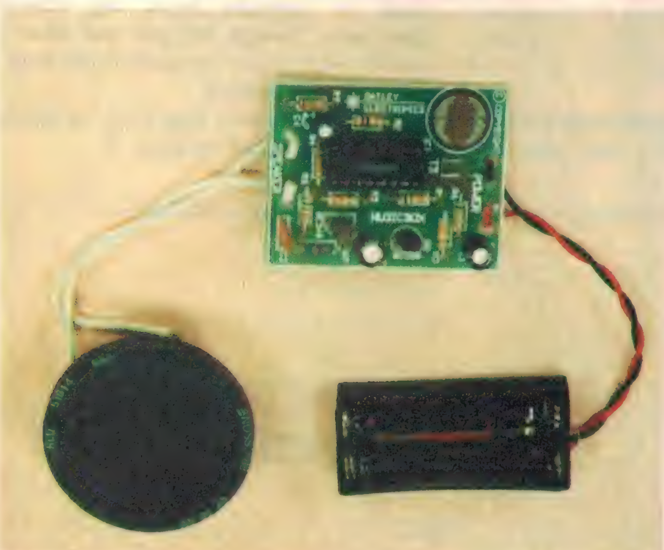
But unlike the latter, there's a choice of tunes. Before listing these, let's look at the circuit so you can see how it works, and therefore how a tune is selected.

Circuit details

As you can see from the circuit diagram, the heart of the project is IC1, a music generating IC. Two IC types are available: the M3485 and the M3481. The latter has eight popular Christmas songs, while the M3485 has five tunes: Hawaiian Wedding Song, Try to Remember, Aloha Oe, Love Story and Yesterday. A tune is selected by operating PB1, which is implemented on the PCB as two wire links placed alongside each other and labelled as TS (for tune select).

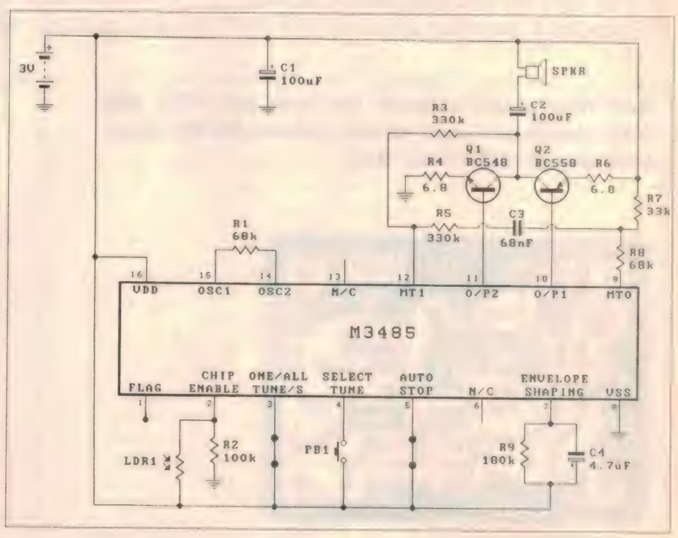
When light falls on LDR1, its resistance falls and the music IC is enabled by the resulting positive voltage at pin 2, supplied via LDR1 from the 3V supply. The IC is configured by the printed circuit tracks so it will play one tune continuously. Details of reconfiguring the IC are given later in this article.

To select a tune, briefly place a short cir-



Above: This simple project is the electronic equivalent to a mechanical music box movement, but with a variety of tunes available.

Below: The heart of the circuit is IC1, a music generator. The speaker is interfaced to the IC by Q1, Q2 and associated components. The musical pitch is set by R1, and light falling on LDR1 enables the IC.



cuit across the TS links, while the circuit is operating. This tune will then remain selected, even when the IC is disabled by the LDR, then enabled later.

The musical pitch is set by the value of resistor R1. Decreasing the value of R1 lowers the pitch, and each tune takes longer to play. The RC network connected to pin 7 shapes the sound, and the values used in the circuit are those recommended by the manufacturer.

The speaker is driven by a complementary pair of transistors, in turn driven by IC1. Notice that the speaker connects from the 3V supply to the transistors, via DC blocking capacitor C2. Negative feedback is provided by R3 to stabilise the DC voltage at the emitters of Q1 and Q2. Further stability is provided by emitter resistors R4 and R6.

Construction

As you can see from the photos, all the components fit on the printed circuit board, with the speaker and battery pack connected by hookup wire. Start by checking the PCB for any manufacturing faults, then solder the resistors and IC socket (if used) to the board.

In the prototype, the wire links that implement PB1 were mounted so they stood about 3mm from the surface of the PCB. The idea is to arrange these so they

PARTS LIST

Resistors

(All resistors 1/4W)

R1,8	68k
R2	100k
R3,5	330k
R4,6	6.8 ohm
R7	33k
R9	180k
LDR1	LDR, PCB mount

Capacitors

C1,2	100uF electrolytic
C3	68nF ceramic
C4	4.7uF electrolytic

Semiconductors

Q1	BC548 NPN transistor
Q2	BC558 PNP transistor
IC1	M3485 or M3481 music IC

Miscellaneous

PC board, 50 x 40mm; 16-pin IC socket; 8Ω speaker; twin AAA battery clip; two 1.5V AAA batteries; hookup wire.

Kit available

A kit of parts for this project is available from Oatley Electronics, of PO Box 89, Oatley NSW 2233. Phone (02) 579 4985, fax (02) 570 7910.

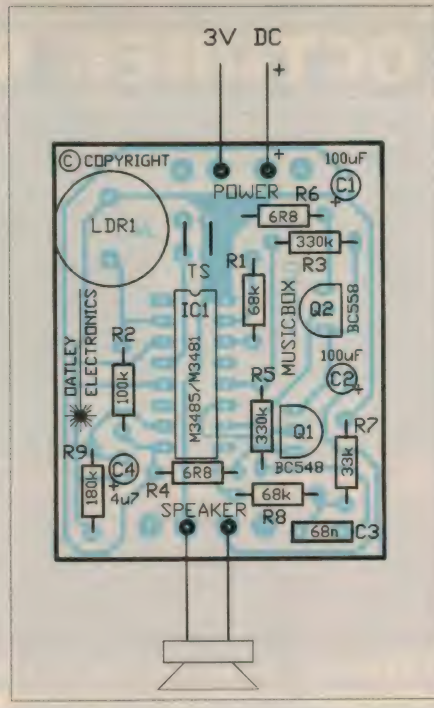
Price of the kit, including all components, M3485 music IC, PCB, speaker and battery clip, is $10.

Additional music IC, type M3481 is $3.

P&P cost is $3.50 (covers any combination and number of kits).

Above: This shot shows a close-up of the PCB. The wires are terminated by passing them through holes in the PCB board before soldering them to the PCB pads.

Right: Here is the layout of the PCB. Note that the links are momentarily shorted to select a different tune.



can be shorted by a coin or similar metal object. Fit these to the board, arranged to suit your needs. If you don't want to ever change the tune, the links can be left out. Alternatively, you might want to run a pair of wires to a small pushbutton, placed discretely to allow changing the tune at any time.

Next solder the capacitors in place (watch the polarity of the three electrolytic capacitors), then fit the two transistors. Note that although the transistors look the same, they are different types, and can't be interchanged. Then mount the light dependent resistor (LDR), so it's flush to the surface of the board. Be careful when soldering the LDR, to avoid damage by overheating.

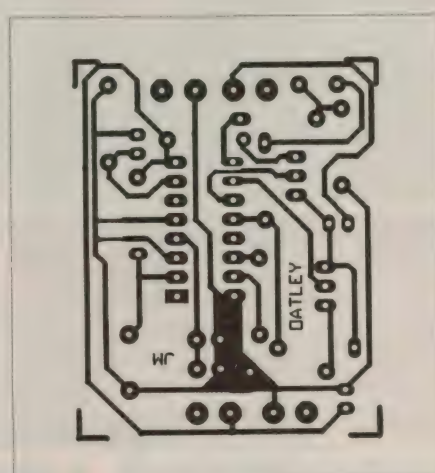
Now connect the speaker and the battery clip with hookup wire. The PCB has holes to pass these wires through, to give a more durable connection. The photos show the idea. Finally, fit the IC to the socket, or solder it to the PCB. Take care not to damage the IC by overheating it, or by electrostatic discharge. That is, used an earthed soldering iron, and touch an earthed object before handling the IC.

Testing

Once all the components are mounted, and you're confident there are no short circuits caused by solder runs, fit two AAA cells to the battery clip. You should find the circuit starts playing a tune while light falls on the LDR. Briefly shorting the links marked TS should cause the IC to advance to another tune, although contact bounce might make it cycle back to the original tune. Cutting off the light to the LDR should make the music stop almost immediately.

The LDR is very sensitive, so even a small amount of light will cause the circuit to operate. To reduce the sensitivity, use a lower value resistor for R2.

The speaker included in the kit from Oatley Electronics is from the handset of a telephone, and has the advantage of being very small. The sound level from this speaker is satisfying, and likely to be adequate for most cases. If you want a higher sound level, use a small 8Ω (or higher) speaker. Alternatively, reduce the value of resistors R4 and R6.



Use this artwork to make your own PCB, if you wish. The design is copyright to Oatley Electronics, and can only be obtained from that firm.

(Continued on page 97)

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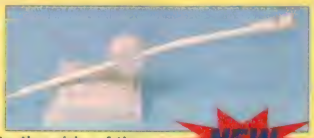

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$15 per metre (x 740mm wide)

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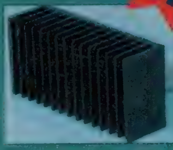

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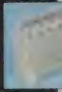

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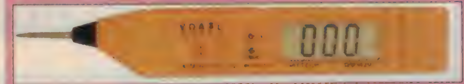

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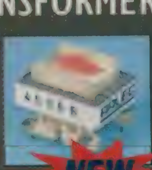

Designed for connecting electronic circuits to Telecom lines. Telecom approval No. RA 88/110. Specs •Impedance - 600Ω line/600Ω or 150Ω equipment. •Frequency response - 200Hz-3kHz. •Insertion loss - 1dB at 0dBm. •Max. level - +20dBm at 200Hz. •Weight - 24g. •Size - 25(L) x 19(W) x 21(H)mm

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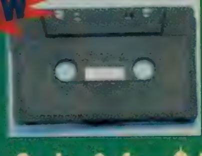

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Construction project:

A LOW COST 'BREATH TESTER'

This project uses a gas sensor especially designed for alcohol breath testers. While the unit is only as good as its calibration, you can use it to see how your blood alcohol content changes over time, and possibly avoid being 'over the limit'. We also give details of how to calibrate the tester — although as you'll read, even the police don't rely on the alcometers used at roadside RBT checks.

by PETER PHILLIPS

Random breath testing has been with us for around 14 years, and yet for most people it's still a guessing game to know if you are over or under the limit. Certainly there are guidelines about how much an 'average' person can consume over a period of time, but none of us is 'average', and guidelines are... well, guidelines.

When you think about, all cars have a speedo, so if you are caught speeding, you have no excuse. You *knew* you were speeding, as the speedo told you. But when it comes to breath testing, even those who don't drink probably breathe a sigh of relief when the testing officer tells you to 'drive on'. After all, alcohol in your breath can come from medication, some types of mouthwash — and of course, alcohol.

So why don't we see a wide range of breath testers on the market? The answer is probably because it's difficult to accurately calibrate a breath tester, and to maintain the calibration. Certainly price is not a major factor, at least with this project, as a complete kit of parts costs around $34. Neither is complexity a problem, as you can see from the circuit. As well, all of the components, except the sensor, are readily available. In any case, the sensor comes in a kit available from Oatley Electronics, the designers of the project.

So before we describe the project, let's look at calibration and the guidelines on drink driving issued by motoring authorities.

Drinking guidelines

The legal limit for blood alcohol content is either 0.02 or 0.05g of alcohol per 100ml of blood. The 0.02 limit includes (in NSW) learner drivers; those with a provisional licence; bus, taxi or hire-car drivers; drivers of a vehicle over 13.9 tonnes, and those under 25 who have held a driver's licence for less than three years.

The usual guidelines are no drinks at all for those whose limit is 0.02. To keep below the 0.05 limit, the NSW Roads and Traffic Authority (RTA) Road Users' Handbook suggests, for women, one standard drink in the first hour and one standard drink each hour after that. Men can usually have two standard drinks in the first hour and one during each subsequent hour.

A 'standard drink' is a middy of beer, a schooner of light beer, a 30ml nip of spirits, a 100ml glass of red or white wine, or a 60ml glass of fortified wine such as sherry. In general, it takes an hour for the body to get rid of the alcohol from one standard drink. However a drinking session during an evening can cause a 0.05 or higher reading the next day.

These guidelines apply to 'standard' people. If you are of a small build, or ill, the number of drinks to remain below the 0.05 limit is less than the above guidelines.

An important point to remember is that your blood alcohol content rises slowly. If you test yourself with a breath testing machine, such as those in the foyer of a club, there's no guarantee that later on your reading will be the same, or lower. In fact, according to the police, a reading of 0.05 at a roadside test could result in a reading of 0.075 half an hour later when the offending driver is tested at a police station. In NSW, legislation requires any subsequent test to be done within two hours of a roadside test.

If you give an RBT reading of 0.05 or more, you are required to undergo a further test at a police station, where the equipment is more sophisticated and more accurate. If you register a reading above the limit at the police station, the might of the law comes down on you and — you know the rest.

Calibration

From the above, you can see that the instruments used at a roadside test are not regarded as accurate enough to result in a conviction. However these instruments must be accurate enough to warrant a subsequent test. So how do the police calibrate their handhelds?

The procedure is surprisingly simple. In principle, a mixture of ethanol and distilled water is supplied to each police station set up to perform the calibration. This mixture is heated to 34°C by a heater immersed in the mixture. A rotating vane suspended in the mixture provides agitation, and air is blown through the mixture from a small com-

pressor. The exhaust from the mixture, taken from a tube suspended above the top of the liquid, is directed over the sensor in the handheld, in the same way as a driver's breath.

A standard mixture comprises 0.735g of ethanol per litre of distilled water. This mixture, when heated to 34°C (+/- 1/2°C), should give a reading between 0.05 and 0.055 on the alcometer. A mixture has a shelf life of six months, providing it's kept refrigerated, and can be used no more than 10 times. A typical calibrating machine takes 500ml of this mixture.

The breath testing equipment at the police station is calibrated the same way. In general, a handheld alcometer is calibrated each month, sometimes more often.

While the above procedure is simple enough, in NSW and probably in all parts of Australia, you can no longer buy ethanol. So where does this leave us when it comes to calibrating this project?

Hints on calibrating

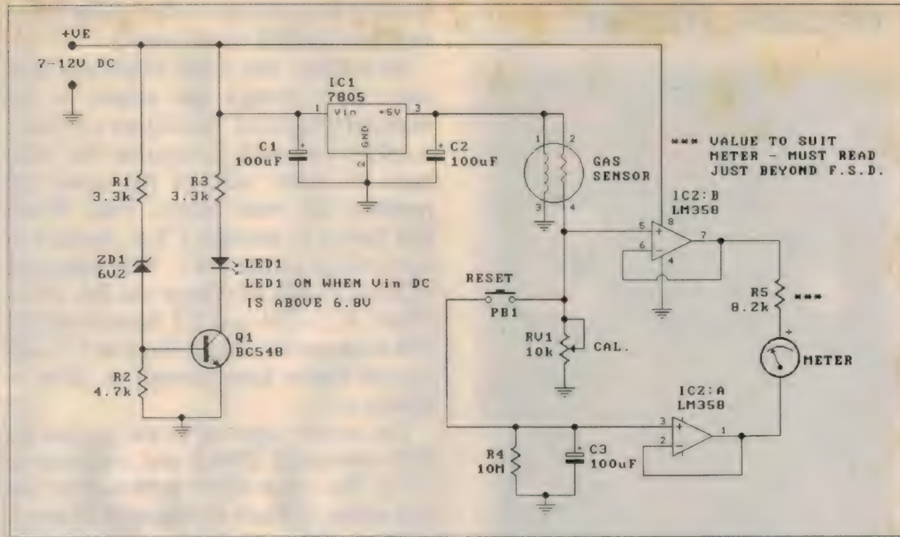
One way to calibrate an alcohol breath tester might be to drink one or two standard drinks, then ask your local police station to give you a breath test. Then when you've established your reading, calibrate the tester with your breath. However a problem here is that many police stations won't give you a voluntary breath test...

The reasons for this include the paperwork that's usually involved, the reticence of police to get involved in this sort of thing, the possible inaccuracies that can result and so on. Still, if you can convince the right police officer, it's possible you'll be given an unofficial test.

Failing that, calibrate the device from a reading you've obtained from a commercial tester, again with your own breath. The problem now is that the commercial tester could be inaccurate. Of course you could repeat the exercise on a number of commercial testers, and average the results!

As a very rough guide, you could consume two middies of beer in a one hour period, and make the assumption that your blood alcohol is around 0.05. This at least gets the adjustment in range, and gives a conservative starting point. This way you have a reference point, and a guide to your blood alcohol content. Another way — which we don't in any way put up as being accurate — is using a mixture of methylated spirits and water. (To blow air through and calibrate the meter, NOT to drink!)

We were fortunate in being able to obtain a bottle of the mixture used by the police, and to calibrate the prototype using the prescribed technique. Then by trial and error, we found that a mixture of 2.5ml of Glendale methylated spirits added to 1.5l of water gave a peak reading of 0.06 on the prototype. We'll have more to say about using this method of calibration later in the article.



The circuit around Q1 operates a LED to show if the supply voltage is high enough. IC1 supplies 5V to the sensor, which is calibrated with VR1. The circuit around IC2 ensures that the meter is zeroed before a reading is taken.

Technical details

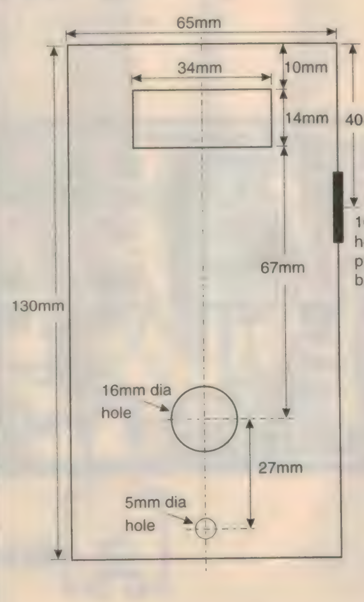
Perhaps the most surprising thing about this project is its simplicity. In fact, the alcometers used by the police are rather similar, with the main bulk of the unit being the rechargeable batteries.

We last described an alcohol breath tester in the May 1983 issue, from a design by Dick Smith Electronics. Sold as a kit, this unit featured a LED bargraph as the display, unlike this project which has a conventional meter as the readout. Another difference to the 1983 project is the support circuitry for the sensor. This new design has a sensor nulling circuit, to minimise errors due to pollution of the sensor element.

The sensor, type AF63, used in the project is described by its manufacturer as a gas sensor sensitive to methane, isobutane, carbon monoxide, benzene, acetone and ethanol. It has a low sensitivity to hydrogen and cigarette smoke. As well, relative humidity and ambient temperature is claimed to have only a small effect on its characteristics.

The sensor has a gas-sensitive resistive element made of a semiconductor oxide, baked onto a ceramic substrate. It also has a thick-film platinum heating element. The sensing element reduces resistance as the gas concentration increases. The heater operates at 5V (+/- 0.2V) and takes around 130mA.

Fig.1



The circuit

The supply voltage for the circuit can range from 7V to 12V DC, and must be able to supply at least 130mA. This voltage is regulated by IC1, a 5V voltage regulator that supplies the sensor heater and the sense element circuitry. Op-amp IC2 is powered by the unregulated supply.

The circuit around Q1 also connects to the unregulated supply, and operates a LED to show if the supply is above 6.8V. The minimum voltage needed by the circuit is 6.5V and if LED1 is out, the supply voltage is too low for the regulator to provide the required 5V for the

A view of the PCB fully assembled. The regulator is bolted to the PCB. See the layout diagram for the meter connections.

sensor. So LED1 is simply an indicator to show that the supply voltage is adequate for the circuit.

The resistive sensing element is connected in series with VR1, a 10k trimpot. The voltage across VR1 rises when the resistance of the element falls due to alcohol-based gas. This voltage is buffered by IC2b, a non-inverting amplifier with unity gain (voltage follower). The output of IC2b supplies the meter movement.

The negative side of the meter connects to the output of IC2a, also connected as a voltage follower. The purpose of this op-amp is to equalise the voltage on either side of the meter before a reading is taken. This is needed to eliminate the effect of contaminants in the sensing element.

To explain: when the sensor is exposed to an alcohol-based gas, its resistance drops. When the gas is removed, the resistance of the sense element slowly rises back to its previous value. However this can take some time. As well, changes in the humidity and ambient temperature have a small effect on the resistance of the sensor.

As a result, the meter might not read zero, even though the sensor is not exposed to alcohol. So, before a reading is taken you need to equalise the voltages on either side of the meter by pressing the reset button, PB1. When this button is pressed, C3 is charged to the voltage across VR1. This capacitor will eventually discharge via R4. So in effect, IC2a, R4 and C3 form a sample and hold circuit. The voltage on C3 will remain stable long enough to allow a breath test.

The meter supplied in the kit has an FSD current of 250uA and a resistance of 1k. The value of R5 is chosen to suit this meter, but can be changed to suit a different meter movement. The purpose of R5 is to limit the current through the meter movement, thereby preventing damage to the meter.

As an approximation, choose a resistor value for a different meter on the basis that the maximum voltage differential between the outputs of the op-amps is around 2.5V.

Construction

Assembly is very straightforward, as all components other than the meter movement and PB1 mount on the circuit board. All components other than the LED and the sensor are mounted flat on the PCB. The sensor is mounted about 1mm above the PCB surface and the LED about 5mm.

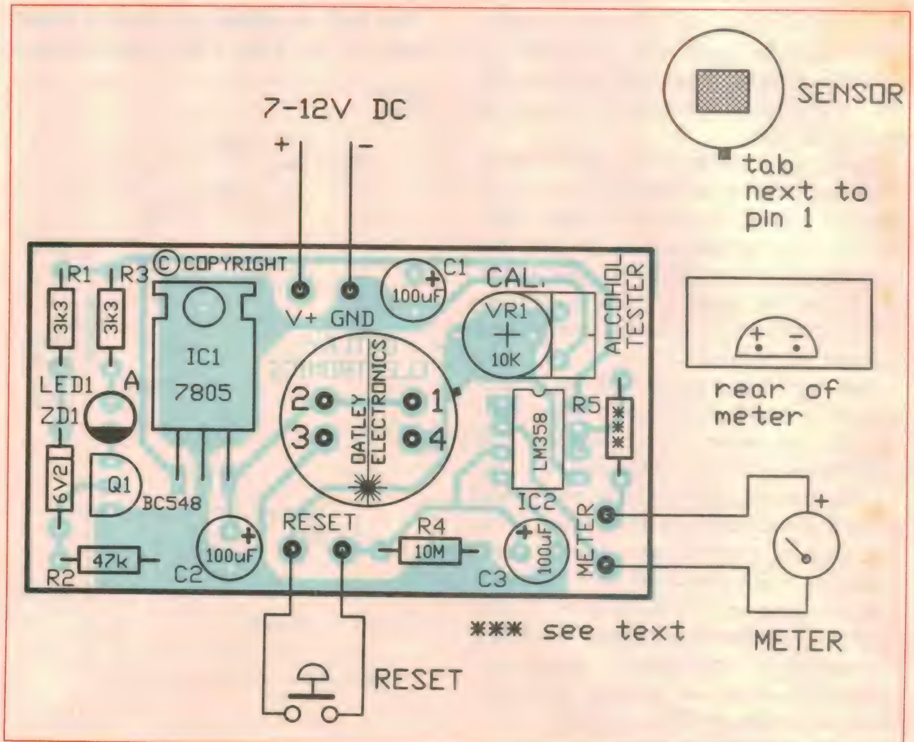
The voltage regulator doesn't have a heatsink and is mounted with its tab flush to the surface of the board. Secure the regulator to the board with a metal thread screw and nut. The photo of the PCB shows the idea.

The prototype was mounted in a small plastic box (130 x 65 x 40mm), with a 16mm hole for the sensor drilled in the bottom of the box. Another 16mm hole was drilled in the side of the box for the reset pushbutton. A 5mm hole is also needed for the LED.

The meter needs a rectangular cutout measuring 34 x 14mm. Fig.1 shows the dimensions and position of these cutouts as done on the prototype. The meter movement and the PCB assembly can be held in place with a dab of silicone glue or similar. File an exit slot for the power supply leads at a point under the lid of the box.

The power supply can be a pack of six AA cells, a suitable DC plugpack or the 12V supply from a car cigarette lighter. A voltage higher than 12V could cause the regulator to overheat, so fit a series resistor to reduce the supply voltage to the unit. Assume a supply current of 130mA and make sure the series resistor has a suitable power rating. If you decide to power the unit from a battery pack, fit an on-off switch.

The layout diagram shows the polarity of the meter terminals, as seen from the back of the meter. Note also that pin 1 of the sensor has a tab next to it.



The layout diagram for the project is shown here. The value of R5 is chosen to suit the meter movement. Use an 8.2k resistor for the meter movement supplied with the kit from Oatley Electronics.

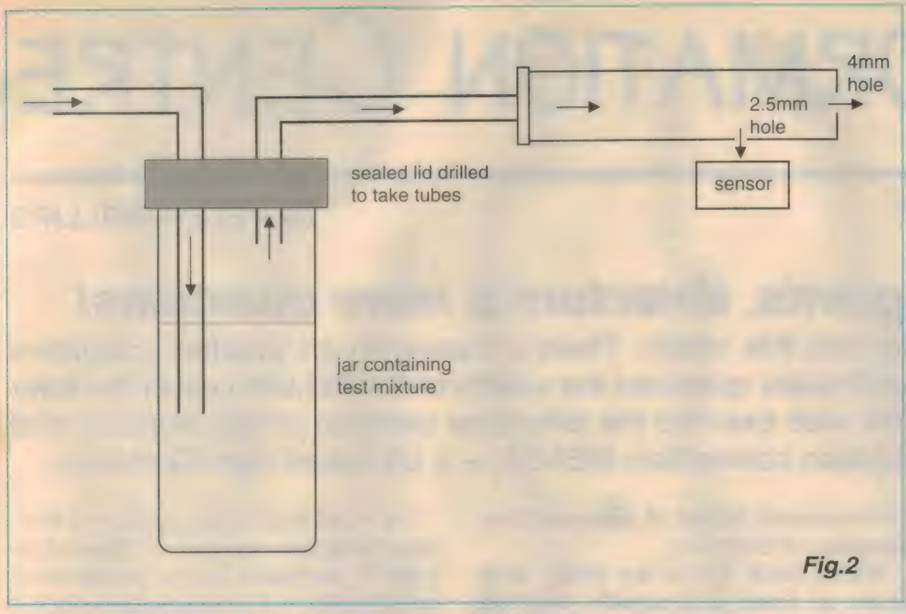
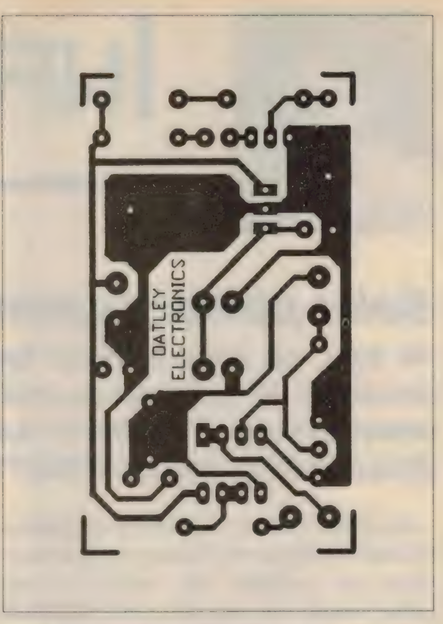


Fig.2



Here's the PCB pattern of the circuit, if you want to make your own. The design is copyright to Oatley Electronics, and won't be be available from any other firm.

Testing & calibration

The unit has to be calibrated before assembly. To do this, connect it to a suitable DC power source and let the sensor heat up and purge contaminants from the sensing element. This could take about 10 minutes or more if the sensor has not been used for some time.

When power is applied to the unit for the first time, the meter pointer will probably go to full scale, then slowly move towards zero. After the meter has stabilised, press the reset button. The meter pointer should now read zero. If it moves away from zero, reset the circuit again, holding the reset button for a second or so. Once the meter pointer is stabilised around zero, the unit is ready for calibration.

The setup in Fig.2 can be used to calibrate the unit, assuming you intend making (or obtaining) a test solution. The solution is placed in the jar (a herb jar is suitable), and holes are drilled in the lid to accept two plastic tubes. One tube is immersed in the mixture, the other well above its surface.

The attachment on the end of the exhaust tube is the white tube you are generally asked to blow in when being breath tested by police. This tube has a 4mm hole in one end and a 2.5mm hole in the body. The exhaust gas from the mixture will flow through both holes, and the 2.5mm hole is positioned about 5mm above the sensor.

As mentioned at the start of the article, it's unlikely you'll be able to obtain or make the exact test mixture used by the police. However as also mentioned before, we found that a mixture of 2.5ml of Glendale methylated spirits added to 1.5 litres of water gave a peak reading of 0.06 on the prototype. The temperature of the mixture was 20°C.

First make sure the meter is zeroed, then blow lightly into the tube immersed in the solution. Direct the hole in the side of the white tube so the exhaust gas flows towards the sensor. Blow for around 10 seconds.

The meter reading will rise, then slowly fall back to zero. Wait about 30 seconds or so for the sensor to stabilise, then repeat the test, adjusting VR1 to obtain a peak reading of around 0.055 to 0.06. The meter scale is already calibrated from 0 to 10, so use these calibrations for the reading. Of course you might want to recalibrate the meter, and use your own scale.

Turning VR1 clockwise increases the sensitivity, and therefore the deflection of the meter. If you blow too hard, droplets of the solution could make their way onto the sensor. If this happens, the sensor will take up to 30 minutes to purge. The sensor heating element is designed to run continuously.

In summary

Although the unit has a professional quality sensor, it's important we remind you that its accuracy is directly related to the calibration. Even if you can accurately calibrate it, and maintain the calibration, this tester, like those used by the police, can still only serve as a guide of your blood alcohol content.

However it will give you a better idea of 'your condition' and will certainly be a hit at your next party. As well, you can use it to see how your blood alcohol content changes during and after drinking. This way you can learn more about how alcohol is absorbed by your body, perhaps compared to your friends. ❖

PARTS LIST

Resistors

(All resistors 1/4W)

R1,3	3.3k
R2	47k
R4	10M
R5	8.2k (see text)
VR1	10k horiz. trimpot

Capacitors

C1-C3	100uF 16V electrolytic

Semiconductors

ZD1	6.2V 330mW zener
LED1	5mm red LED
IC1	7805 TO220 5V regulator
IC2	LM358 dual op-amp
Q1	BC548 NPN transistor

Miscellaneous

AF63 gas sensor; PC board, 36 x 63mm; 8 pin IC socket; 250uA meter movement; N/O pushbutton; plastic utility case 130 x 65 x 40mm; hookup wire.

Kit available

A kit of parts for this project is available from Oatley Electronics, of PO Box 89, Oatley NSW 2233. Phone (02) 9579 4985, fax (02) 9570 7910. Price of the kit, including all components, PCB, sensor, pushbutton and case, is $34 plus $4.50 for P&P.

WARNING

Please note that the calibration techniques described in this article cannot be assumed to be accurate. They are provided as a guide only — as is the Breath Tester project.

INFORMATION CENTRE

by PETER PHILLIPS

Solar power system grants, detectors & more questions!

As ever, we have a mixed bag for you this month. There's discussion on whether computers should be left switched on, and a contributor questions the validity of the $33,000 cost of the solar power system described in July. We also examine the difference between phase inversion and phase shifting, and our What?? question comes from MENSA — a US based high-IQ society.

As a child, I was continually in trouble for leaving lights on. During my teenage years my troubles got worse, as my father would find my radio left switched on, equipment in my fledgling workshop still running, and so on. To avoid these problems I devised all sorts of schemes to automatically switch things off.

When I was 18, I linked a mains operated bedside radio to a mechanical clock that was supposed to turn the radio off at a particular time. I dismantled it some months later when I discovered it gave me a 'tingle' when I touched the clock and the radio chassis!

By the time I got married, virtually all of my electrical equipment had some sort of auto-switchoff system. However this brought about other problems. For instance when my wife first operated my sound system, she took so long selecting a record that the system switched itself off. Concerned that she had broken it, it was weeks before she mentioned the event and she has never tried to operate my sound system again; and that's after 25 years.

When I studied electrical and electronic theory I began to wonder if my father was right in making me turn off all unattended electrical appliances. I was learning that appliances usually fail at switch-on, and that lights take a surge of power when first turned on. As I progressed in my studies, I also learnt that the heating and cooling caused by the power on/power off cycle was a contributing factor to the failure of an electrical appliance.

These days I am far more pragmatic about leaving an appliance or a light switched on. While I have never actually calculated the cost, I am now rather convinced that the overall saving in repairs and light globe replacement is likely to make this a more cost effective thing to do. Of course one has to consider safety and other factors, such as the environmental impact of increased consumption of electricity.

Which leads me to my point. Is it better to leave a computer switched on? I'm prompted to ask this on the basis of our first letter, which I'll present now and then continue with a few thoughts. The letter asks a number of questions, including replacing the CMOS backup battery.

Computer problems

I have owned my 486DX computer now for just over three years and have been advised that the average life of the battery that keeps the CMOS chip powered up when the computer is switched off is about three and a half years; and that I should think about replacing it before it fails. I'm also told that if I'm quick enough, I can do the swap without losing the CMOS settings. It seems that an internal capacitor will keep things going for a few minutes with the battery disconnected.

My informant also tells me that the best thing I can do is to leave the computer turned on, and to just switch off the monitor. By doing this, he claims I will prolong the life of the electronics and extend the life of the backup battery. But if this is true, what happens to the bearings in the hard drive? They must have a working life, or would they be OK running non-stop?

My last question concerns the MS backup program. After completing a full backup (with verify checked) and noting the catalog number, I used the COMPARE command to check my work. However half way through disk six, a message came up telling me the catalog does not match.

I clicked CONTINUE and no other problems occurred. So what did the alert message mean, and how will it effect the restore function? Hope you can clarify. (John Barker, Thames, NZ)

Let's first look at the question of leaving a computer switched on. These days a lot of computers have a power-down function that will automatically switch it off if there's no activity after a preset time. But I'd guess, John, that your computer doesn't have this feature.

It's generally agreed by those I've discussed this with that today's hard drives, that is those with a voice-coil head drive mechanism, can run continuously. Older style drives are not usually up to this task, although I know of many cases, such as with bulletin boards, where old computers (286 etc) have run for years. We keep the computer (a 386 with voice coil drives) for *EA*'s bulletin board on continuously, and have done so for nearly a year. We turn the monitor off overnight, but other than that, the system is always on.

It's also generally agreed that leaving a computer on all the time is better for its electronics. In my experience, the most common failure of a computer is its power supply, which if it fails usually does so at switch on. The inrush current that charges the main filter capacitors is the usual reason for their failure.

As well, heating and cooling is a common reason for soldered joints failing due to the associated expansion and contraction. Mind you, despite knowing this I still turn my computer off each night, as somehow I'm not happy about leaving it or any electrical appliance running when I'm not around. Shades of my youth perhaps!

Regarding the backup battery, I own a computer bought in 1986 which still has its original backup battery. Other systems I've owned have backup batteries that have lasted well over the three or four years your informant claims as their life span. But in any case, I recommend you keep a written copy of your CMOS memory settings. These settings can be lost for reasons other than failure of the

backup battery, and if you have them written down, it's easy to restore them.

Most computer systems allow the backup battery to be removed and replaced without loss of information. A trick a friend of mine uses is to replace the backup battery with a bank of alkaline AA cells. These have a shelf life of over three years and are also relatively cheap and easy to obtain.

As for your backup program, in my opinion if the software is alerting you to a problem, then you have a problem. I would guess a restore will not be successful. However, I've not experienced this, and can't give you a definitive answer. If it was me, I'd do another backup.

Solar's true cost

In July, I presented a rather lengthy letter sent by a contributor who had recently installed a large solar power system in his property. I presented the letter in answer to a reader enquiry, and also because I felt it would be of likely interest to readers. But it may be that our contributor didn't tell the full story. See what you think after reading the next letter.

In July, Information Centre was significantly uninformative in dealing with the practicalities of solar power. Curiously not disclosed is that your contributor owning the $33,000 solar system was the recipient of a 66% grant from NSW RAPAS. In practice, these grants tend to end up at around 80% or more of the total cost, depending on how honest the 'consultant' is. So, frequently the only design criterion is one of consuming the entire one-off grant.

Your contributor owns a system capable of running two and a half arc welders, as each Selectronics inverter can run an arc welder, and his generator can run the remaining half arc welder. He never has to run the generator and can run a conventional fridge AND freezer. No cost-benefit analysis was done here.

I calculate that about $17,500 of his equipment will be dead in 10 years. His batteries have a whopping 62kWh capacity (for 100 hour discharge rating: multiply 10 hour by 1.6). So while he is using his panels at 70% capacity in winter, the parts that decay are being used at about 6% capacity.

The non-solar media enjoys showcasing particularly large systems and labelling them costly, but I would like to point out that such instances are best ignored, not highlighted as advice.

The fact is, a reasonably user transparent power system will cost less than $13,000 if nobody is throwing money at you. Here's a system to justify this figure: 12V BP 660Ah cells at $2300 (Mum got some recently); Woods 80A charger for $750 (most people would buy a 40A version); a 2kVA generator costing $1200 or less; a control panel for $700 which includes a luxury BP accumulator; solar panels, eight x 60W for a total of $3752 (Whitworth marine price was $3376 in July); panel mounts for $80 if you make them yourself; a CSI 1kW 12V sine wave inverter at $2000 (has a massive overload capacity); gas fridge/freezer for $1400, but deduct $800 for the price of a conventional fridge; a second non-sine wave 1.2kW inverter, for toaster etc. This all comes to $12,582.

Admittedly this system is tailored for a Sydney climate. Southerners might need a good diesel generator during winter. (Chris Johnson-Walker, Whiporie, NSW)

Thanks for this information, Chris. I assume you have more than a passing interest in solar power, although I have no idea how you reach the conclusion that our previous correspondent was the recipient of a grant. And I'm not even sure if that fact is relevant. If a grant is available to those wanting to install solar power, then I would like to make this known, as my introductory comments in July made the point that this is the only way we are going to get a shift from grid power to alternative power systems.

However, having worked in Government institutions for many years, I'm aware that all kinds of tricks are pulled to maximise a grant. But whether this applies here or not is irrelevant.

More to the point is the system you describe. I assume this system is based on your knowledge of typical solar power systems, and that it will provide sufficient power for a typical household. If so, there's quite a difference from the $33,000 cost quoted by our previous contributor.

In any case, if our correspondent received a 66% grant, he would still need to have spent around $11,000. Of course your point is that you think his system is overpriced (or over engineered). Perhaps other readers can comment, as it's always good to get the facts.

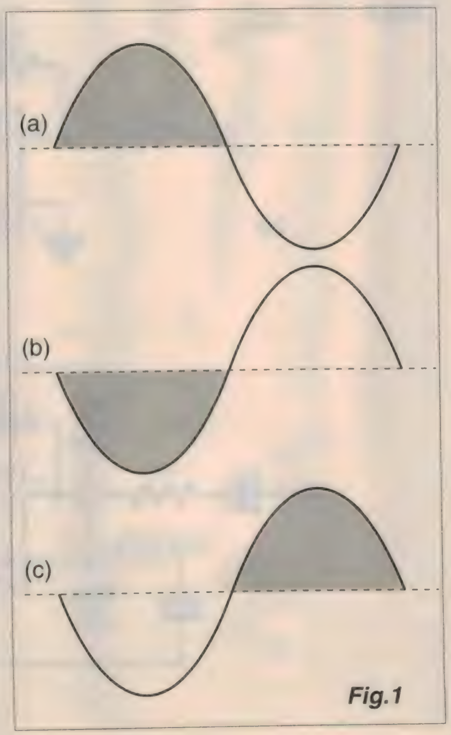


Fig.1

Phase shift vs inversion

In the April '96 issue I answered a question from a reader enquiring about 'a circuit that will make exact mirror images of an analog signal. For example, if the input is a sine wave, the output should be a sine wave that's upside down'. To me this meant a circuit where the output is 180° out of phase with the input, or as I put it in my reply: "... or one that changes the signal by 180°." However perhaps I've confused some of you, or at least the next letter claims that I could have. The writer prefers to remain anonymous, and also makes a further point about the inverting op-amp circuit I presented. Here's the letter...

I believe some readers might misinterpret your statement "... or one that changes the signal by 180°" to mean that polarity inversion of a waveform can be achieved in general by the application of a 180° phase shift. This of course is a matter that often leads to confusion, as explained in the attached articles.

You also mention that a disadvantage of using an op-amp is the need for a dual polarity power supply. This is not correct. I have often had to design op-amp circuits to suit existing single supply rails. All you have to do is bias the op-amp to half the supply rail at the non-inverting input to set the output to half the supply voltage. For AC circuits this configuration is very simple; much simpler than building your Fig.2. (name withheld)

The 'attached articles' were (1) by S.W. Amos, titled 'Phase Confusion', from the English magazine *Television* February 1979; and (2) a letter in the May 1979 issue of the same magazine, pointing out a mistake in the article. The thrust of the article by Amos is that phase inversion and phase shift are total-

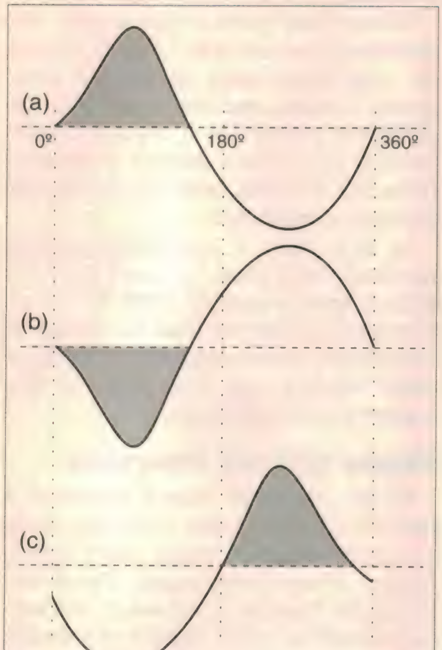


Fig.2

ly different concepts. While I don't believe I've confused anyone by my comments in April, it's worth spending a few minutes looking at the difference. Amos says:

If a symmetrical wave such as a sine wave — so often used for test purposes — is phase shifted by 180° the result is the same as inverting the wave. This is shown in Fig.1. Indeed a phase shift oscillator makes use of this identity.

But it does not follow from this that inversion is in general equivalent to a 180° phase shift. If it was possible to identify the output corresponding to a particular half-cycle of input, it would be found that an inverted output is coincident in time with the input, whereas a phase-shifted output is non-inverted but is delayed in time by half the period of the wave.

The article continues at some length, explaining that the two are very different treatments, making the point that phase shift is always accompanied by signal delay, where the delay is given by the phase shift divided by the frequency.

I don't propose taking this any further, as the article by Amos becomes quite complex, and frankly I found it rather difficult to follow. However, I've reproduced the Fig.1 referred to by Amos, and another which shows quite clearly the differences when an asymmetrical waveform is assumed (Fig.2). Incidentally, it was this diagram that was incorrect, as pointed out by the contributor to the May edition of the magazine. I've presented the corrected version.

Returning now to the op-amp circuit, yes I agree that it's a simple matter to bias the non-inverting input of an op-amp so it can operate from a single supply. However, I don't agree that this is always simpler than using a dual polarity power supply. My reasons for saying this are: (1) Some op-amps don't take kindly to single rail operation. (2) Up to five extra components are needed and (3), the circuit will only work with AC signals.

But for a circuit where there's only one op-amp, and for AC signals only, I agree it's simpler that building a dual polarity power supply. I've included the circuit sent by our anonymous contributor, along with the circuit I presented in April. See Fig.3.

Pet door

We get a lot of suggestions for projects, such as this one:

Have you considered designing an electronic device to operate a pet door? The idea is to exclude unwanted animals, and to only let the house pets use the door. Such a door could be operated by an identity IC either attached to a flea collar, or embedded in the animal.

These devices are available, but cost around NZ$150, and are only suitable for attachment to a collar, which means you run a considerable risk of it becoming detached and lost. For this reason I suggest an implant. Such a project would be most useful in Australia, as it would mean dangerous animals like snakes would be excluded, a particular advantage in country areas. It would appeal to many people if the project was available as a kit. (P. Hutchings, Palmerston North, NZ)

Hmmm — An interesting idea, but one that I doubt we would be game to do. Attaching an IC to a collar is one thing, but implanting it is definitely another. But thanks for the idea, and we'll see what we can do.

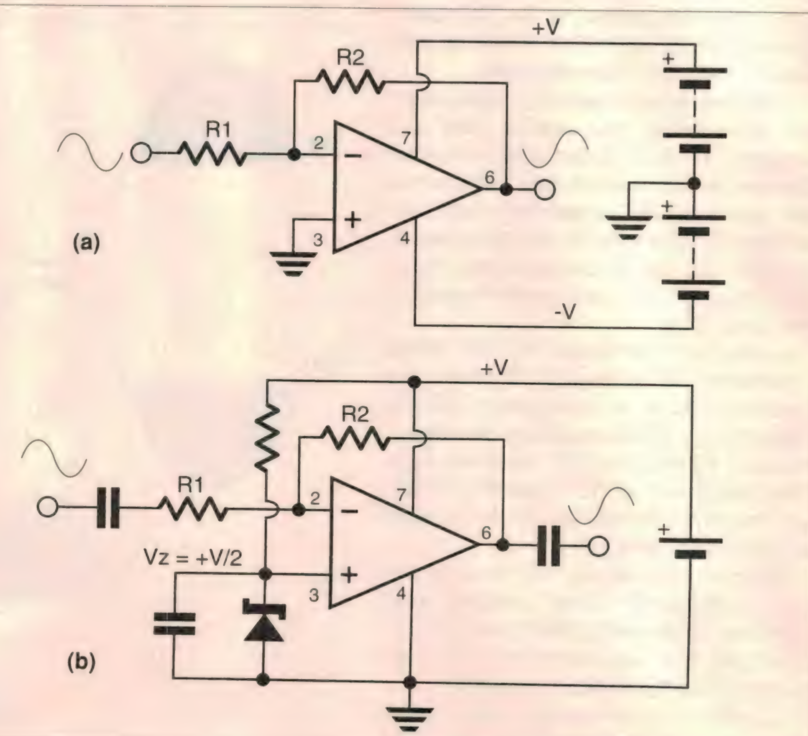
Synchronous detector

In July I briefly discussed the synchronous detector (SD), in answer to an enquiry. I included a simple circuit and, based on the texts I referred to, made the point that this detector is different to a product detector. The next letter disagrees with me on this, and makes a few points about the SD that I think you'll find interesting.

Some of the points you made about synchronous detectors in July need, in my opinion, to be clarified. The SD is indeed widely used in radio (not that TV isn't radio), such as in FM stereo decoder ICs, as demodulators or as phase sensitive detectors (PSDs) in phase locked loop configurations. Beyond this SDs have many obvious applications in professional and commercial radio/communications networks.

You note that the product detector and the SD operate on a different principle.

Fig.3



This is not true. No matter what the application is for either detector, they operate on precisely the same principle and some texts refer to them as the same thing, although it's possible to get into debates over semantics.

In any case they are both classed as coherent, switching or multiplier type demodulators. This is as distinct from non-coherent detectors such as the simple diode envelope detector which, on analysis, also relies on a multiplication process for its operation, even when operating in rectification mode.

A synchronous detector is described in the 1995 ARRL Handbook for Radio Amateurs, but it is very complicated, even though it doesn't offer separate sideband selection. To add this feature would involve the reverse process of the third method of SSB generation, enough for anyone to conclude such a system would be worth every bit of $1000. However, after the novelty wears off in about a year, you will wish you'd spent the money on a new fridge or washing machine. (Phil Lockley, West Pennant Hills, NSW).

Thanks for this information, Phil. After reading your letter I referred back to the text I used previously, and after a re-examination, I have to agree with you. It seems the text (*Electronic Communication Systems,* by Frank Dungan, Delmar US, 1993) is rather confused in referring the reader first to a product detector circuit, then without warning continues explaining the product detector, but with reference to the SD circuit.

However, like Dungan, all the other books I checked separate the SD and product detector circuits. One text makes the point that a product detector does not have to be as accurate as an SD, but other than that, it certainly seems that the operating principle is similar in that diodes are switched in synchronism with a regenerated carrier.

I received another letter about this topic, from a reader who wants to remain anonymous. The letter is too long to include here, but the writer makes the point that the $1000 price tag of a commercial synchronous detector is not as outrageous as it seems. As the writer says: "If you want quality, you have to pay for it — or put another way, you get what you pay for."

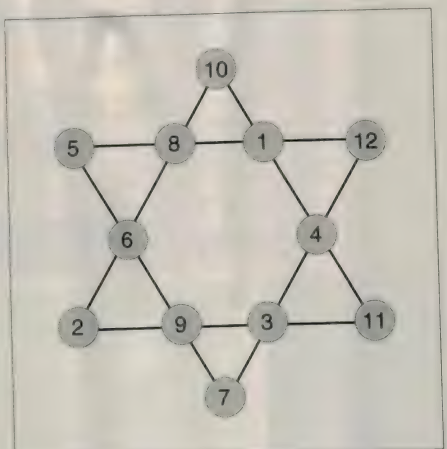
July's What??

I'm always delighted when readers send in solutions to the What?? questions I pose. The July question resulted in a lot of readers sending me the answer, probably because I introduced it as 'one I would like to award a prize for'. Everyone who sent in the answer got it right, but only a few people saw through the question. Those that did wondered why I wanted to award a prize for it, as the question seemed too simple...

And that's *why* I wanted to make it a prize winning question. Most people set about solving it with mathematics, when all it needed was simple observation. Yes, it was simple — but that was the trick. So if you used mathematics to solve it, be assured you were in the majority. I think only about one in 10 letters saw the answer immediately. Try it on your friends!

Puzzle

The intriguing puzzle shown in Fig.4 was sent by a reader who acknowledges he can't solve it, despite years of trying. You need to rearrange the numbers so all lines add up to 26. If anyone can solve it, please let me know. The puzzle was sent by Linden Beswick from Launceston, Tasmania. Linden is also very keen to know the answer.



What??

I was recently loaned a book called *Games for the Super Intelligent*, by James F. Fixx. A lot of the mental teasers in this book have been contributed by members of MENSA, an exclusive society for those with a very high IQ. (I think Bill Gates is a member of this society.)

Interestingly, when I first looked through the book I recognised quite a few of the questions, so it seems I've already been giving you MENSA-grade questions. Because good questions are hard to find, I'm going to occasionally pick a What?? question from this book. Be assured, they'll all have a simple answer, without recourse to maths and science. Just logic and a bit of lateral thinking is all you'll need. Try this one, which I've reworded to give it an electronic feel:

You have three component drawers, labelled respectively as RESISTORS, CAPACITORS, and RESISTORS AND CAPACITORS. All you know is that each label is on the wrong drawer. You are allowed to select only one component from one drawer. (No peeking or feeling around inside the drawer!) How can you correctly label each drawer?

Answer to September's What

Since Sam gained the highest number of points, he must have won most races and we can deduce that he failed to win only one race. We do not know how many races were held, but we do know that the points awarded for first place must have been at least three, because the points for second and third place were worth progressively less. This means there must have been less than seven races (20 divided by 3).

Trying scores of 3, 2 and 1 for the contestants results in no combinations which add up to Michael's and Colin's scores. We can rule out 4 or 5 as possible first place scores because these numbers are factors of 20, and do not allow for Sam to lose a race.

If we allocate 6 or 7 as first place scores, there must have been four and three races held respectively, and one of the minor places must have been worth 2 or 6, respectively. Again there are no combinations of lesser scores which add up to Michael's and Colin's scores.

However, if eight points are given to first place, then three races must have been held and Sam was awarded four points for the race he didn't win. If Michael won that race, winning eight points for a total of 10 accumulated points, then he must have come third in the other two races, picking up one point for each of these third places.

Thus the points were 8, 4 and 1 for first, second and third respectively, and Michael won the preamp assembly race. ❖

EA'S READER SERVICE BBS

As part of our service to readers, *Electronics Australia* operates a Reader Information Service Bulletin Board System (BBS), which makes available a wide range of useful information for convenient access and rapid downloading. You can also leave contributions to some of our columns.

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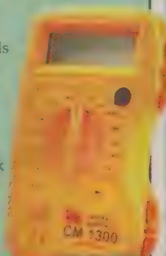

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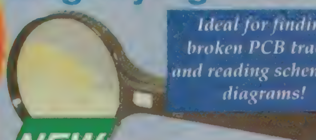

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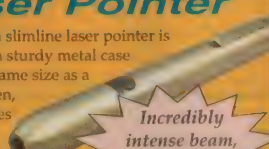

This stylish slimline laser pointer is housed in a sturdy metal case about the same size as a fountain pen, and includes a pocket clip. Ideal for lectures, guided tours, seminars, even building sites, and its much less intrusive than a normal stick pointer! Push-to-activate operation. Uses two AAA cells (included!). Supplied with soft storage case.

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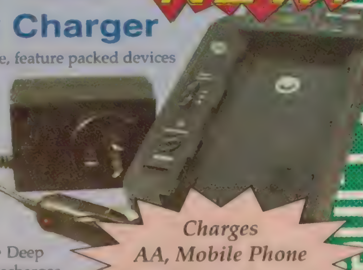

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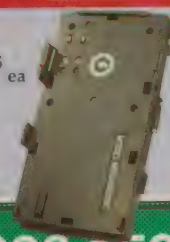

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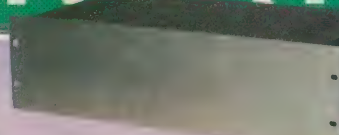

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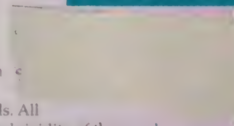

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H 5122	2U	88	Natural Anodised	$19.95	$15
H 5123	3U	132	Natural Anodised	$25.95	$20
H 5131	1U	44	Black Anodised	$17.95	$14
H 5132	2U	88	Black Anodised	$20.95	$16
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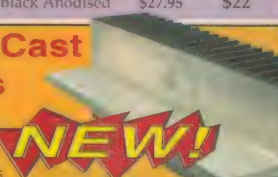

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Experimenting with Electronics

by DARREN YATES, B.Sc.

Digital Electronics: an introduction to CMOS circuits

This month, we start looking at the strand of electronics from which just about all things have sprung — games machines, PCs, CD players, the Internet and you name it. We'll look at the humble beginnings with circuits, you can create using your own 4000-series CMOS integrated circuits.

It's not strictly true to say that we haven't been looking at digital electronics up until now. In fact, many circuits we've looked at already come straight out of the pages of this field of electronics.

Now while digital electronics is experiencing far more exposure these days than analog, it's arguably *less* interesting if you're a keen electronics enthusiast. Of course if you're more into computers and programming, then digital electronics will probably interest you more...

Most people tend to congregate in one corner or another when it comes to picking a field to study, but it's important to remember that digital electronics requires understanding of analog first. Most of the reasons should be obvious, but one of the most important and fundamental reasons is that the real world is an analog world. Rarely in nature do you get on/off changes. We don't get instantaneous changes from night to day, but rather continuously varying levels of light from day to night.

The key words here are 'continuously varying'. This is the sign of an analog situation. The digital world or 'domain' works in discrete steps, which can be as simple as an 'on/off' step or more complex — such as the 65000-odd steps in the output of your CD player. Analog electronics is still needed to convert these discrete steps back into real-world signals like those for audio amplifiers and speakers. (Yes, there *are* digital audio amplifiers, but they're in the minority...)

Unfortunately, though, many people who start learning electronics start here and then wonder why they get totally stumped about 10 pages into a course. There's also this misconception that digital electronics is easier than analog. Don't bet on it. Once you've had to diagnose why a digital clock using basic digital logic ICs doesn't work properly, you'll soon know why.

Digital circuits have a much greater capacity to be compacted into little black boxes than analog circuits do, so it can often be much harder to understand completely how a digital circuit works.

Digital ICs

Back when I first took over the EWE column, we looked at a couple of circuits using diodes and transistors that performed a few digital logic functions. While those circuits work well, you can't beat the real thing (that sounds familiar...).

Over the next few months, we'll be looking at digital circuits using CMOS ICs. These will more often than not come from the 4000-family, the oldest and I think the best CMOS logic family for simple low-frequency, low-power circuits. You can buy the chips we'll be using from your favourite electronics store.

CMOS (pronounced 'see-moss') stands for Complementary Metal Oxide Silicon. I was told once that the only real reason this is worth knowing that is because it invariably turns up in exam questions...

While the name describes the physical construction of the chip, it also gives us a guide to one of the reasons that CMOS has been so popular. The 'complementary' part means that the output stages are *complementary*, or mirrors of each other. While this may be difficult to understand initially, it allows CMOS outputs to swing fully between both supply rails. For example, with a 9V supply rail, a logic 'high' will be 9V and a 'low' will be 0V.

Fig.1

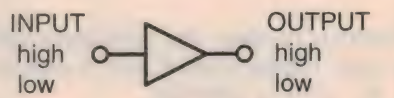


Fig.2

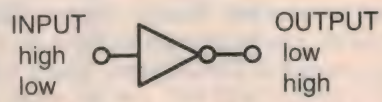
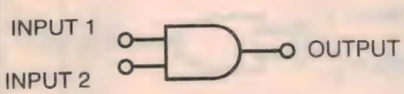


Fig.3



		INPUT 2: 0	INPUT 2: 1
INPUT 1	0	0	0
	1	0	1

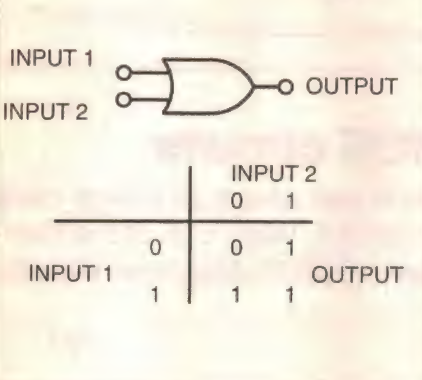
OUTPUT

The older 74xx TTL family couldn't do this, because they weren't complementary. Instead they used what's often termed a 'totem-pole' arrangement, where you have two transistors of the same type in series and you turn them alternatively off and on to get an output. Supply rail swings are much more difficult, if not impossible with this method.

High input impedance

The other factor which makes CMOS doubly good for battery circuits and an improvement over TTL is their incredibly high input impedance. Whereas TTL chip input impedance is in the order of

Fig.4



hundreds of ohms, the input impedance of your regular CMOS gate is around 1 x 10^{12} ohms or 1000GΩ.

You don't need a very strong signal to make an impact with a CMOS input. In fact, there are circuits that use the 50Hz mains hum from your fingers as an input — that's how sensitive they are.

This brings up potential problems, though, such as static buildup on clothes. The voltage you can carry on your clothes just through normal static build up can be enough to blow up the input stages of CMOS gates. That's why most people will tell you to wear an earth strap or at least earth yourself before you touch any CMOS ICs. By the same token, I've been playing with them for years and have never had a problem. Rather than being paranoid about everything, I think a good practical rule is be careful with *any* IC costing more than \$5 — especially on dry, windy days.

Digital gates

Before we launch into some circuits, we should take a look at the basic digital logic gates. These eight gates form the basics of all digital electronics. Combinations of these gates form more complex building blocks which form more complex blocks again.

Starting in Fig.1, we have a non-inverting *buffer*, the simplest gate of all. It does nothing to the input signal except produce a lower-impedance copy at the output. Gates such as this are used when sending a signal to a number of inputs all coupled together. They reduce the load on the original input signal.

The opposite of a buffer is an *inverter*, which as its name suggests takes the input signal and outputs the opposite. So if the input is low, the output is high and vice versa. The schematic symbol is shown in Fig.2.

What! Old symbols?

Now I know I'll generate a few letters with these diagrams, and I'm sure there are a few pencil-pushers already crying foul because I haven't used the latest standard symbols. Tough! Just about all of the current engineers and technicians who are working in the field (rather than those who simply sit back and make even more rules) learned these symbols, and as far as I can see, the earth is still turning very nicely, thanks very much.

These symbols are distinct, clear and much easier to remember than a bunch of boxes with unintuitive squiggles.

"They're easier to draw using a PC" is the return cry. So what? These symbols here were also drawn on a PC, and anyway if you have a PC to do the drawings, who cares if it has to work a little harder to make things clearer for we humans?

I make no apologies for not following the latest standards. There are too many standards. These symbols have been around for years, are still almost universally used in Asia and the USA, and there are plenty of schematics which technicians will have to read in years to come which use these classic symbols. So we should still be helping you get familiar with them, despite the head-in-the-sand mentality that quite often pervades. In any case they've served the industry well for many years and I see no reason to change...

Fig.5

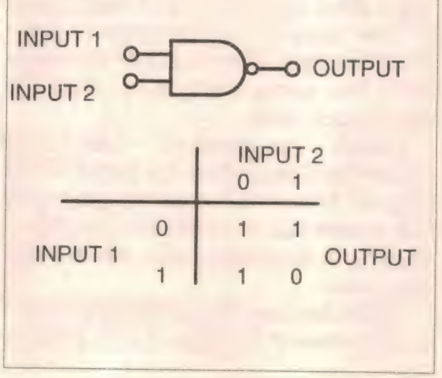
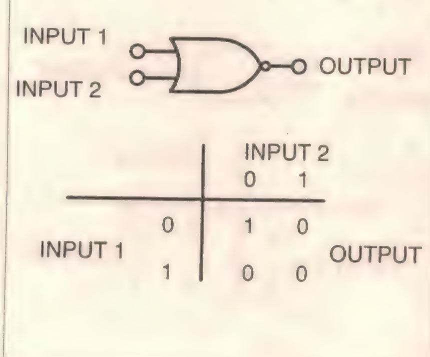


Fig.6



But back to the inverter in Fig.2. We've seen in the past that this logic gate can be as simple as a single transistor, but the CMOS version uses the same complementary output stage used by other CMOS gates — which ensures that we now get a full supply-rail swing at the output.

The two gates of Figs.1 and 2 are the simplest, with only one input and one output. The following gates all have multiple inputs and a single output. It's possible to find some of these gates with up to eight inputs.

The first of these gates (Fig.3) is the AND gate. By the way, each gate's name should give you at least a clue as to its operation. With an AND gate, all inputs must be high for the output to be high. In the case of Fig.3, input 1 AND input 2 must both be high for the output to be high. In all other cases, the output will be low. Note that if you tie both inputs together, you have a buffer just as in Fig.1.

Fig.4 shows the OR gate, which operates differently from an AND gate in that either input 1 OR input 2, or both, can be high for the output to be high. Again, if you connect both inputs together, you end up with a buffer.

These two are the basic control gates. The next two gates combine each of these gates with an inverter gate to give us two new gates — the NAND and NOR gates.

Looking at Fig.5, you can see the only difference between the NAND and AND schematic symbols is the little circle or 'bubble' at the output of the NAND gate. This circle represents a built-in inverter, just as you can see between the buffer and inverter gates in Figs 1 and 2. The name NAND is an abbreviation for 'NOT AND', which means that the output is high only when input 1 AND input 2 are NOT high.

If you compare the tables for the AND and NAND gates, you'll see that for any combination of inputs for the AND gate, you get the opposite output from the NAND gate.

Note here again that if you join the two inputs of a NAND gate together,

Fig.7

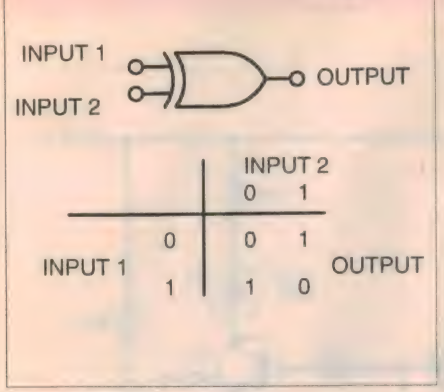
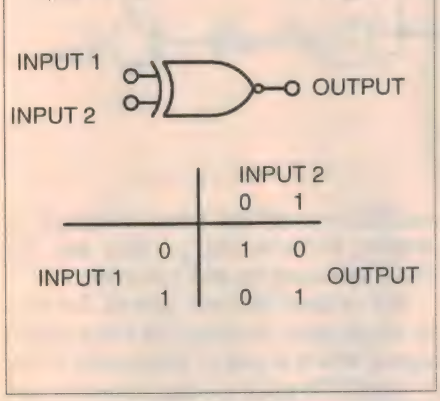


Fig.8



you get the same function as the inverter in Fig.2.

The same can be seen in Fig.6 with the NOR gate. This gate is a NOT-OR function, so its output is high only when input 1 OR input 2 OR both are NOT high. The only time the output is high in this gate is when both inputs are low. Again, connect the two inputs together and you get an inverter.

The fact that you can create gate functions from other gates is important and a handy thing if you are trying to keep your designs as compact as possible. For example, if you need an inverter but only have a NOR gate left in an IC package (they usually come in fours), then you simply connect the inputs together and there you have it — a makeshift but perfectly useable inverter. Or maybe you need an NAND gate but only have an AND and an inverter. In that case, you connect your inputs to the AND gate and connect its output to the inverter. The output from the inverter will give you the NAND function.

Finally, we come to two gates which take care of the situation where you need to produce an output for either input being high, but *not* both. The XOR gate in Fig.7 is an 'exclusive-OR' function, which means that the output is high when either input 1 OR input 2 is high, but not both. The XNOR gate in Fig.8 is simply the inverted output version of the XOR gate, so that the output is high when both inputs are high or low together.

Points of order

The last two gates are less commonly used in circuitry, but no less useful. It's worth noting now that there are two CMOS IC packages available for the XOR gate and they're the 4030 and the 4070. Wherever possible, use the 4070 version. This IC has an extra gain stage inside it, and is much better than the 4030. Some circuits we'll look at require the extra gain provided by the 4070 to work properly.

Another thing worth noting too is that when buying CMOS ICs, make sure unless the circuit specifically asks otherwise to get *buffered* versions of the gate. By this we mean the IC code should have a B immediately following the last digit — for example, a 4011 buffered NAND gate IC should read '4011B'. You can have whatever letters you like before and after, but it should read '4011B' somewhere. This indicates that the output has a buffer stage to ensure that has a better chance of driving whatever load you connect up to it. It won't handle a couple of 12V globes, but it will provide more signal that an unbuffered version.

What the buffer stage does is to ensure that you don't load down the input logic stage and upset the logic calculation.

Note that if you connect up a load on the output which is too low in impedance, the output may drop low enough to be considered a 'low' rather than a 'high', so you need to be careful. We'll look at what you can hang off a CMOS output in a moment.

Whereas TTL required a fairly hefty 5V supply rail, CMOS circuits can be run anywhere from 3 to 15V and most require only a proverbial 'sniff' to run. The only difference will be any other ancillary hardware, such as buzzers or LEDs you decide to also connect to your circuit.

How much is 'too much'?

One of the most common mistakes made with CMOS circuits is expecting the output stage to drive whatever load you have and still keep working. While CMOS output stages are reasonably low impedance, they're not designed to drive relays, speakers, LEDs or other high-demand devices. Which begs the question — how much loading is too much?

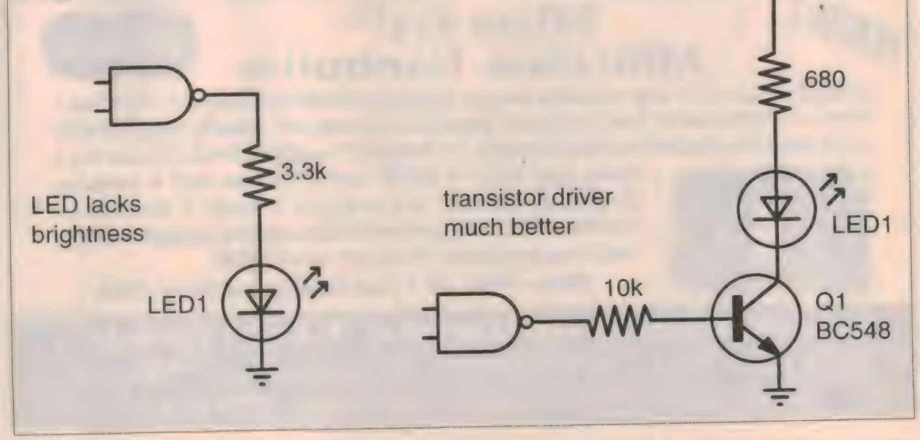
As a hard and fast rule, never put a load of less than 10kΩ on the output of a 4000-family gate. If you want to stretch things a little, it starts to depend on your supply voltage. CMOS gates can pump out and sink more current with a high supply rail. If you're running below 10V, don't use a load less than 6.8kΩ. Above 10V, no less than 4.7kΩ.

Now of course, you could try and push that further, but the output levels will not be close to the supply rails if you do. These figures are for the buffered CMOS versions only. The unbuffered versions, signified with an A after the number, as in '4011A', can handle only lighter loads.

If you have to drive heavier loads, then use a transistor driver between the output of your gate and the load device. An example of this is shown in Fig.9. Driving a LED from a NAND gate is not the best way to go, although it will work to some degree. The NAND gate doesn't have enough current drive to light up the LED, and you need at least a 3.3kΩ resistor to ensure that you don't overload and possibly damage the output stage.

The best method is to use a NPN transistor with the load in the collector. Any NPN device will do — a BC548 being ideal for this situation.

Fig.9



Being more conservative will cost you more in terms of a component count, but you'll end up with less erratic problems in the future.

Circuit starters

To start the ball rolling, we'll just look at a couple of circuits. The first circuit, in Fig.10, is probably the most common logic circuit you'll find — the two-gate CMOS oscillator. Take any two inverter gates and you'll get them to oscillate when connected up in this fashion.

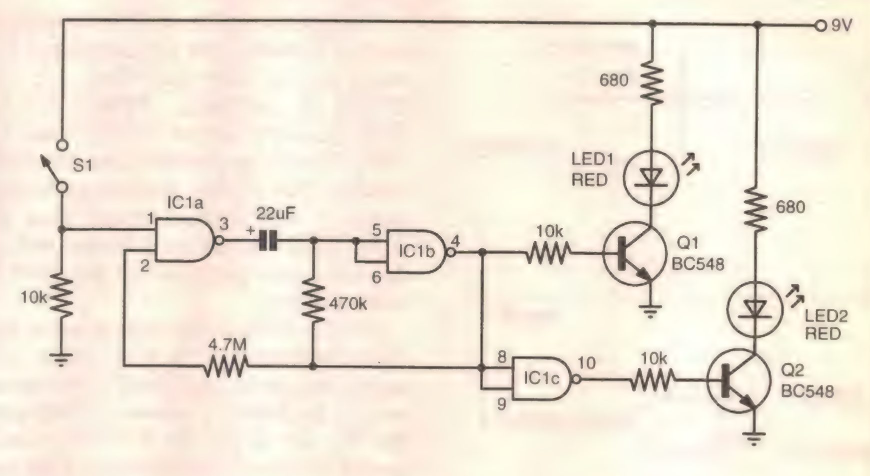
The circuit relies on the logic change-over threshold being nominally at half the supply voltage. It works in much the same way as a transistor RC oscillator, with the output change of IC1a causing the capacitor to drop its voltage at the input of IC1b by the same voltage. The capacitor then must charge in the opposite direction, until the level threshold causes the output to change again.

Let's say IC1b's output is initially high and that of IC1a is low. The capacitor C now charges via IC1b and resistor R1. Once the capacitor charges past the threshold level, IC1b flips over, which causes IC1a to flip over as well. The capacitor now discharges via the same path until it reaches the lower threshold, at which point the gates change their state and the process continues on.

Resistor R2 isn't strictly necessary, but is still a good idea in any case and should have a value of 10 times R1. Its job is to ensure some isolation between the input of IC1a and the rest of the circuit, and it makes sure that the signal at the output of IC1b has sharp transitions which are not loaded down by the capacitive inputs of IC1a.

Using this circuit, you can get frequencies of 2MHz and above; but it will depend somewhat on the ICs. Some ICs will operate at higher frequencies than others, by virtue of their manufacture. You can't pick the high-frequency ones, you can only test them as you go.

Fig.11



The circuit in Fig.11 could be used as a simple railway crossing flasher, or in any number of places. It uses one of the spare NAND inputs as a control. With the control input low (S1 open), the oscillator is off but when it is high, it enables IC1a to change state and the oscillator starts up and continues.

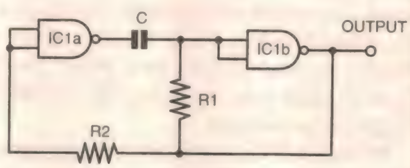


Fig.10

We've used the extra gate (IC1c) here as an inverter, to create an extra output signal which is out of phase with IC1b. Connect this up to another transistor and LED as shown, and you have a pair of alternately flashing LEDs whose frequency is controlled by resistor R1 and capacitor C.

Note the way the control input is connected. When there is no specific signal connected to it, i.e., the switch is open, the 10kΩ resistor pulls the input down to ground to ensure that it doesn't float around. Because of their high input impedances, the floating input could respond to radiated hum and falsely start the circuit. The 10kΩ resistor ensures that this will never happen.

Of course, this is not the most efficient way to create a twin LED alternating flasher, but it shows how we can build upon our knowledge and use it in our circuit designs.

OK. Now that we've laid down the basics (and they are only the barest of basics), we can look at some more complicated logic circuits next time.

If you'd like some more in-depth reading, the *CMOS Cookbook* by Don Lancaster is an excellent read and one of the best books to start off with when looking at logic circuits — focusing in on CMOS ICs. It's been around for years, but should still be available at your favourite electronic bookstore.

Next month, we'll continue looking at some logic circuits using these basic gate functions. ❖

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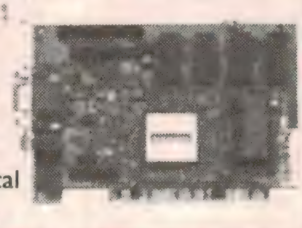

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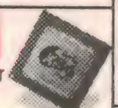

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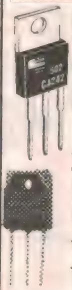

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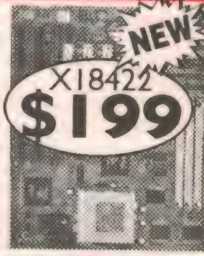

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Construction Project:

A PC-BASED 32CH LOGIC ANALYSER - 1

PC-based test instrument designs make a lot of sense, because they can often deliver a high order of performance at a significantly lower cost. Here's a PC-based Logic Analyser which offers 32 TTL/CMOS input channels, sampling at up to 40MHz and fully maskable 32-channel triggering — all under software control.

by DAVID L. JONES and DAVID BULFONI

Although many readers of *EA* would be aware of what a logic analyser is and what it does, how many actually *have* one — or have even used one?

I wouldn't be surprised if I didn't see too many hands for the second part of this question, and even fewer for the first part. Why? Because the humble logic analyser is quite an exotic, expensive, and sometimes intimidating piece of test gear.

Just what *is* a logic analyser, anyhow? Well, the simplest answer is that it can be considered as a bunch of logic probes, all simultaneously capable of reading digital data and storing it in memory. The captured data is then displayed as a series of digital 'waveforms' which show the time relationship between the digital input signals.

Some new (read expensive) logic analysers also have very fast analog to digital converters to provide an oscilloscope type display of what the *actual* waveshape is, as well.

The main use of a logic analyser is when you need to measure more than a few digital input signals simultaneously. In fact, nothing can really take its place in this kind of situation.

With the proliferation of microprocessor controlled equipment these days, debugging the hardware aspects of new designs can be a nightmare without the use of a logic analyser.

But what makes the logic analyser so special, and better than an oscilloscope and/or logic probe for some digital troubleshooting? There are three main reasons, the first being that the logic analyser is capable of capturing single-shot or 'non repetitive' data, that can't be viewed on a normal non-storage oscilloscope. Of course, a digital storage oscilloscope is capable of capturing single-shot digital events, but they are generally expensive and can only handle a few channels at most.

The second advantage of a logic analyser is that it can capture dozens and even hundreds of channels at the same time. This allows you to analyse different events happening at the same time, and shows the relationship of one event to another. It also allows you to analyse the data and address buses of microprocessors.

The third advantage is that a logic analyser can be triggered on a certain 'event', or combination of input conditions. For example, you can set it up to trigger off a certain microprocessor memory address, and capture the data before and after that address is accessed.

As good as a logic analyser is, many people still tend to use just a logic probe and oscilloscope for digital troubleshooting and circuit verification most of the time. This is because a logic analyser is generally quite 'fiddly' to use and time consuming to set up, especially if you know exactly what the circuit is supposed to do.

But when it comes to multiple channel non-repetitive digital signals, the logic analyser will become one of the most valuable piece of test equipment on your bench.

Projects for test equipment have been very popular in *EA* over the years — which is not surprising, considering that it's one field where you can still make a lot of your own equipment for much less than the cost of commercial units. But because of its cost and complexity, the logic analyser has been the one noticeable exception.

Commercial logic analysers tend to start in the four-digit price range and work their way up. One of the main rea-

The author's prototype for the new Logic Analyser. With 32 fully maskable input channels and able to sample at up to 40MHz, it's very suitable for troubleshooting in many digital systems.

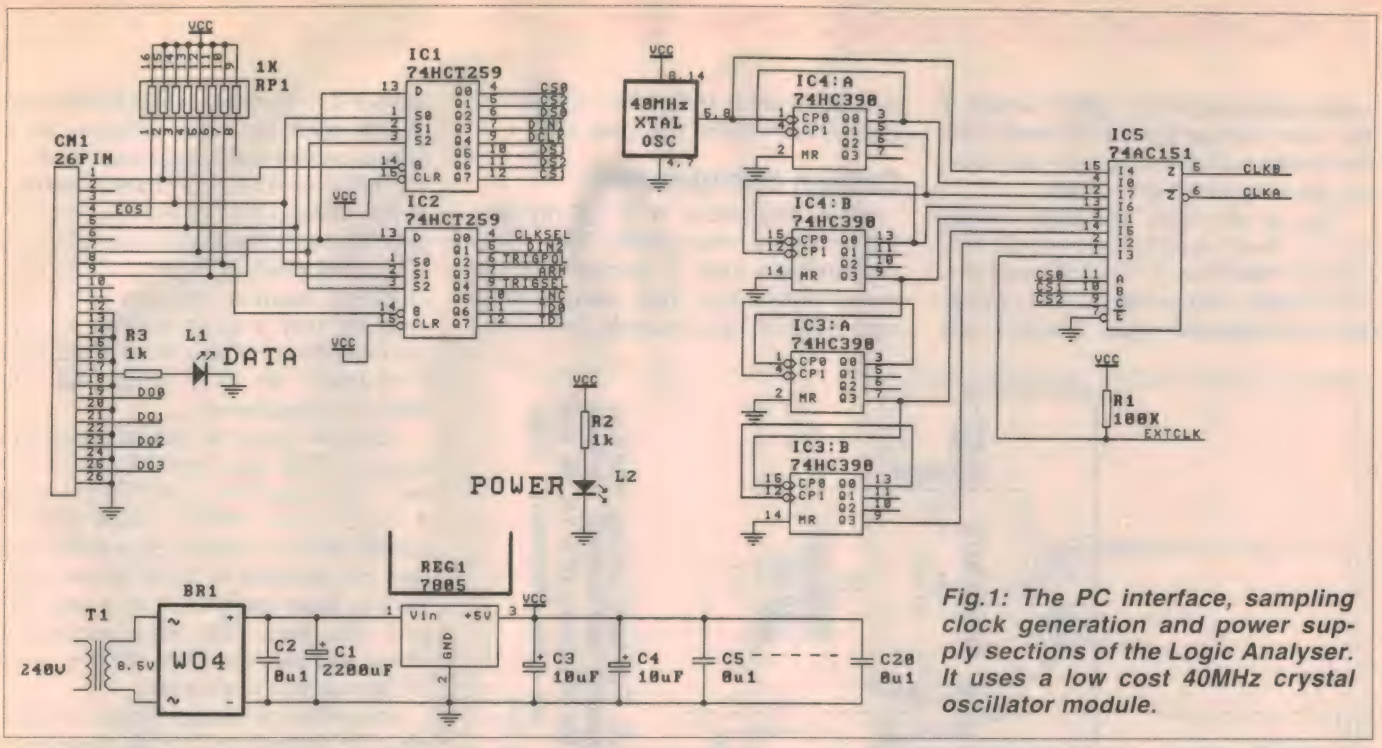


Fig.1: The PC interface, sampling clock generation and power supply sections of the Logic Analyser. It uses a low cost 40MHz crystal oscillator module.

sons for the high price is that most commercial units have their own screen and firmware to drive it, which puts the price out of the reach of the hobbyist — and many organizations as well!

In fact, though, it's not very difficult to design your own logic analyser. The basic operation is quite straightforward; all that is needed is some memory, a word trigger circuit and some simple control logic. A standard PC can be used to retrieve the stored information and display the required waveforms.

So why hasn't a simple logic analyser design been published before? The main reason is the sheer number of chips needed. To be really useful, a logic analyser must have many channels. Eight or 16 channels is fine for simple circuits, but if you're dealing with microprocessor buses, then 32 channels is much more useful. So, although the basic concept is simple enough, multiply it by 16 or 32 channels and you have a lot of circuitry!

New design

The new EA PC-Based Logic Analyser (or PCLA) to be described here, while being very simple in concept, has most of the features required for serious debugging of most digital circuitry. It provides 32 TTL-level input channels, as well as external clock and trigger inputs. The external clock and trigger inputs can be inverted under software control. The trigger circuitry is capable of setting each of the 32 channels to trigger off a HIGH, LOW, or DON'T CARE condition. The trigger signal can also be delayed by two, four, or eight clock cycles.

There are seven different internal sampling rates of 40MHz, 20MHz, 10MHz, 5MHz, 1MHz, 100kHz, and 10kHz. The maximum sampling rate is 40MHz internal and 20MHz external (more about this later).

At the same time the project is simple to construct, on one single-sided PC board. It connects to a standard PC parallel port, which controls all aspects of the project. As such, there are no front panel switches or controls. This also lowers the cost of the project, as a control chip is cheaper than a switch and wiring.

Two 34-way levered IDC header connectors are used for the 32 input channels (16 each), along with the external clock and trigger inputs. A five volt supply output is also provided on the connector to allow the addition of external level converter and buffer probes.

SPECIFICATION

Number of input channels:	32
Compatibility:	TTL/CMOS
Control:	Fully PC controlled
Sample Rate	Internal: 40, 20, 10, 5 and 1MHz, 100 and 10kHz
	External: Up to 20MHz positive/negative (see text)
Triggering:	Latched trigger word/mask
	External — positive/negative
	Internal — 32 channels, fully maskable
	Optional glitch capture (see text)
Software:	Address/data disassembly Measurement cursors
Options:	External buffer/trigger boxes

Types of analyser

Before we go any further, it's important to understand the two different types of measurements a logic analyser can make. One is called TIMING analysis, and the other is called STATE analysis. They both capture basically the same information, but it depends on what you want to measure that determines what mode you will use.

The simplest description is that TIMING analysis is *asynchronous* to the data being measured, and STATE analysis is *synchronous*. In other words, TIMING analysis uses an internal sample clock independent of the circuit under test, whereas STATE analysis uses a sample clock from the circuit under test.

So why not just call the two type of analysis internal or external clock? The terms come from the way the captured data is interpreted. In TIMING mode, you can actually measure the TIME difference between two data points or events, exactly like an oscilloscope. In STATE mode you are looking at what is happening in the circuit as it changes from one state to another, in step with the master clock from the circuit under test.

STATE analysis does have one disadvantage, in that it is difficult (read 'complex and expensive') to design the logic analyser to match the delay of the sample clock and the data. This is important

when measuring at high speed, because if the clock that latches the incoming data for storage is a little too late or early, then the data may no longer be valid.

This is why logic analysers usually have a lower specification for STATE analysis than that of TIMING analysis. This design is no exception, and as such, the recommended upper sampling rate in STATE mode is half that of TIMING mode. (More about this later, too.)

Design background

When I set about to design my own logic analyser using discrete 74xx series combinatorial logic, it became clear that a minimum of three chips was needed for each group of eight channels, just to store and retrieve the data — plus a minimum of five chips per eight channels, for a fully maskable word triggering circuit.

I really wanted a 32 channel design, so this meant a total of over 32 chips — and when you include the control logic, it's getting close to 50 or so chips! This might not seem so bad, but when you consider that a good number of the chips need to be connected with parallel 8-bit buses, the PCB design and size becomes a nightmare...

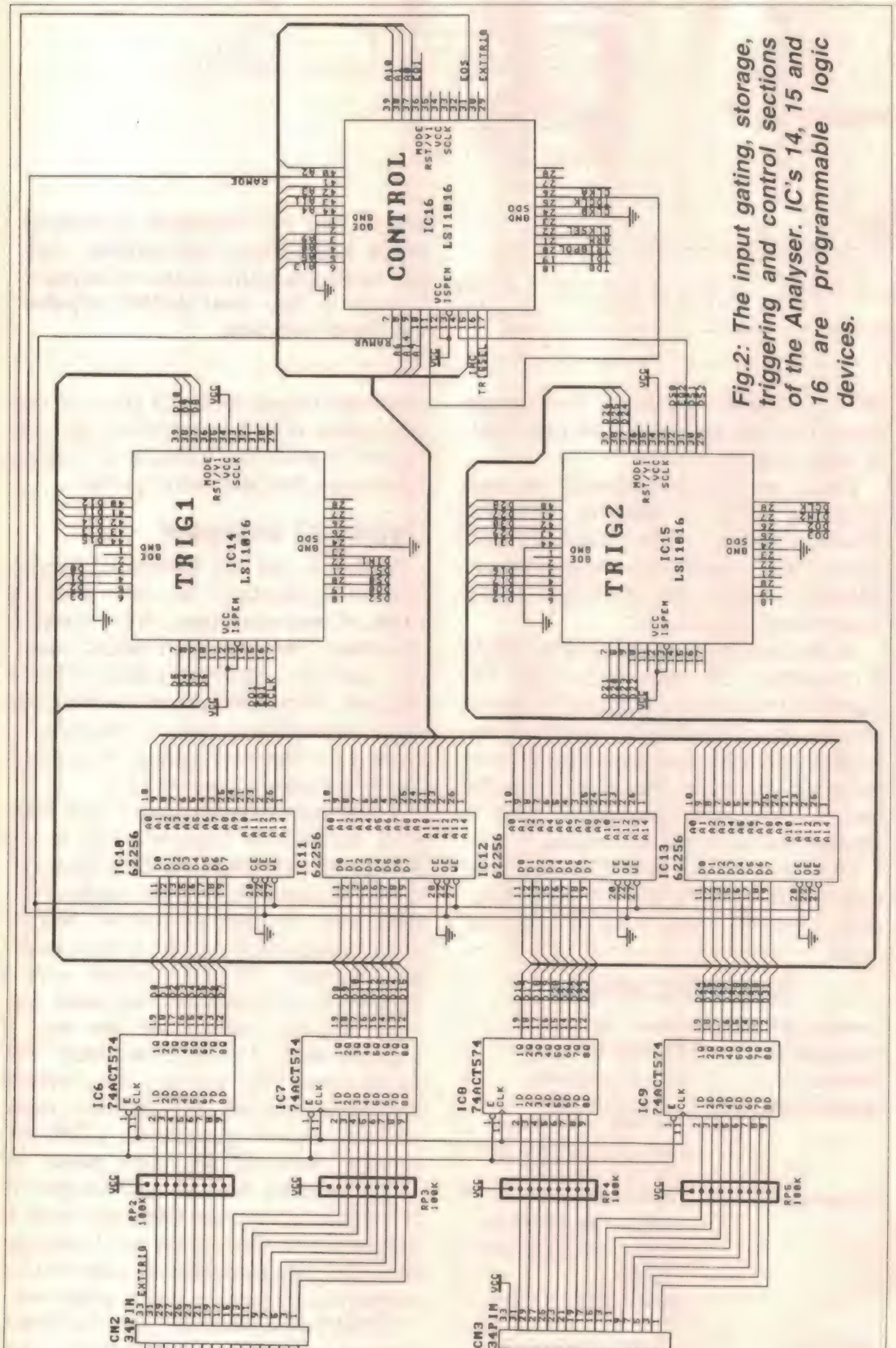


Fig.2: The input gating, storage, triggering and control sections of the Analyser. IC's 14, 15 and 16 are programmable logic devices.

I tried to break the design down into separate PCBs that would handle 8-bits each, but even then, each PCB has to be a quite dense double sided plated-though board. It became clear that it was just not possible to build a low cost, easy to build logic analyser using normal 74xx logic. The sheer number of chips and the complex double sided PCB(s) simply ruled it out.

So how has *this* design done it? A complete 32 channel fully mask triggerable, 40MHz, delayed triggering, PC controlled logic analyser that fits onto ONE self-contained single sided PCB? OK, so the design doesn't use all discrete logic, but I'm sure you'll agree it was worth it.

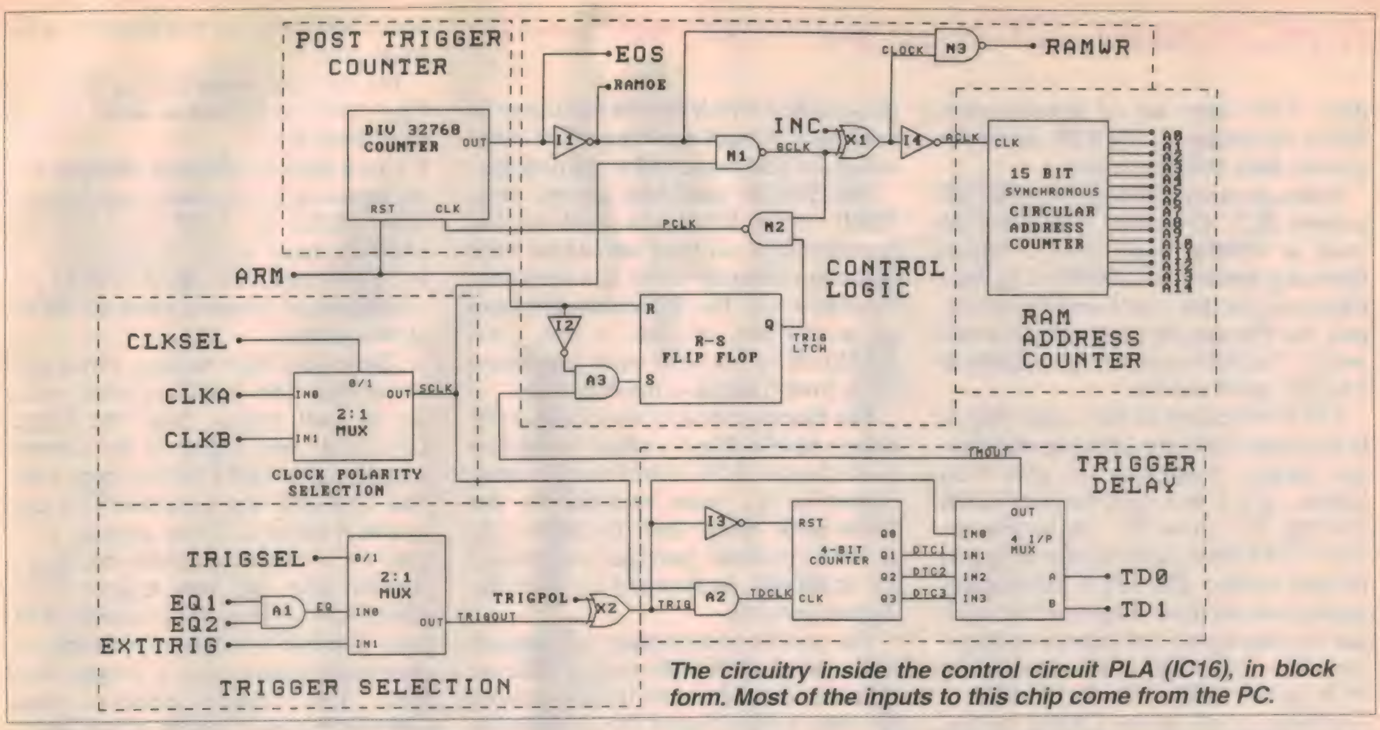
Programmable chips

If you take a look at the main circuit (Figs.1 and 2), you'll see how the design has been compressed onto a single sided PCB. Three Lattice Semiconductor large scale integration (LSI) programmable logic devices (PLDs) have been used for most of the control circuitry and all of the maskable trigger circuitry.

The Lattice 1016 PLD's contain the equivalent of about 2000 standard logic gates. They are also fully in-system programmable, which means that they can be re-programmed whilst in circuit using a dedicated serial bus. This feature is not included in this design however.

The good thing with this arrangement is that virtually no hardware is required to program the devices, they are simply connected to a 5V supply and connected to a normal PC parallel port. They are then programmed using the download software available from Lattice.

There are actually two versions of the LSI device. One is the ispLSI1016 which is in-system programmable, and can be reprogrammed over a 1000 times. The other is the LSI1016 which must be programmed with a commercial programmer, and is only programmable once. There is a substantial cost saving by using the one-time programmable LSI1016, but if you program it incorrectly or want to



The circuitry inside the control circuit PLA (IC16), in block form. Most of the inputs to this chip come from the PC.

modify it, then you're up for the cost of a new chip! So here it is preferable to use the reprogrammable ispLSI device...

The bottom of the range 1016 (ispLSI1016-80) is rated at 80MHz, which is more than adequate for our 40MHz application.

Most of the 44 pins on the 1016 are programmable as either inputs or outputs (or both) — which provides flexibility in PCB design, and is the main reason why the design can be fitted onto a single sided PCB.

The use of PLDs also reduces the cost of the project, even if you just take into account the cost of the chips that they replace. This is not to mention the cost saving on the PCB.

However, the other great advantage of PLDs over discrete logic is that if you have multiple gates connected in series, the total propagation delay is much smaller with the PLD. This is because the PLD connects all the gates together very closely on the same piece of silicon. Whereas with discrete logic, the propagation delay increases proportionally with each gate added.

This aspect of PLDs is very important for the trigger circuit, as the final trigger signal has to have passed through about seven gates before it registers the 'trigger' in the trigger latch. Even using very fast and expensive '74F' series logic, it would be hard to make a 40MHz analyser. But the PLDs lower this propagation delay to effectively two gates.

Fully pre-programmed PLD devices for this project are available (see elsewhere), or you can program and modify your own devices using the low cost (about $150) PDS LSI starter kit, available from Lattice Semiconductor dealers. Full internal schematics are provided here, and the actual LSI design files are available for downloading via the EA BBS or on disk from the *EA* Reader Information Service.

Circuit description

The main schematic of the discrete logic can be broken down into four main sections. The first section is the parallel port interface, comprising ICs 1 and 2 (Fig.1). These 74HCT259 devices are 8-bit addressable latches, which are used to give a total of 15 control lines to operate the PCLA. This was required because the parallel port only has 12 output lines, which was not enough for the functions I wanted to add. They also have one other purpose in that they provide a debounce function for all of the control lines. This is needed to make the lines immune to 'ringing', which can cause multiple clocking on those lines that are used as clock inputs.

It would have been nice to incorporate the functions of IC1 and IC2 into the main control LSI, but the lack of additional internal resources forced the use of external chips. Anyway, you didn't want EVERYTHING to be inside those little square chips, did you?

The second section of the circuit is the clock generation and selection section, comprising ICs 3, 4, and 5. The purpose of this section is to provide a range of clock frequencies which can be used as the sample clock in TIMING mode. Alternatively, an external clock can be selected, for use in STATE analysis mode. The 74HC390 devices used in the divider stage are dual decade counters. Actually, each four bit counter consists of a separate /2 and /5 counter. The output of the /2 counter is tied to the clock input of the /5 counter to produce a decade counter.

A TTL crystal oscillator module is used to generate the 40MHz master clock which is fed to the first clock input of IC4a, to produce 20MHz and 10MHz clock outputs on pins 3 and 5 respectively. The 10MHz clock then clocks the next counter, which gives outputs of 5MHz and 1MHz; and so on with IC3, which generates a 100kHz and 10kHz clock. The PCB can cater for both 8 pin and 14 pin oscillator modules.

All of these clock frequencies are fed into IC5, a 74AC151 8-channel multiplexer controlled directly from the PC with control lines CS0, CS1, and CS2. The multiplexer generates both normal and inverted outputs of the selected clock signal, CLKA and CLKB. The polarity of the output makes no difference in TIMING mode, because the clock is asynchronous with the input data. But in STATE mode, when the external clock input is selected, the polarity is important as this determines what edge of the clock the data will be sampled on.

A 74HC151 can be used instead of the AC series device is desired, but the HC device will provide greater 'skew', or delay between the external input clock and the actual sampling of the

data. This may be of consequence when operating in STATE mode at greater than 10MHz or so.

Although many brands of the 74HC390 counter (IC3, 4) are not 'guaranteed' to work at 40MHz, most have a typical operating frequeny of 50MHz. I haven't found one yet that won't work in this circuit, but this may be something to watch out for. The 390 is not readily available in a higher speed version.

The third section of the circuit (Fig.2) is the input buffering, latching, and storage section comprising the four 8-bit latches (ICs 6 to 9) and the four 32KB SRAMs (ICs 10 to 13). The latches are 74ACT574 octal positive edge triggered tri-state latches. The 574 is functionally identical to the more common 374, but it has the data inputs and outputs on opposite sides of the chip — which made the PCB layout easier. The ACT series is essentially a low power CMOS version of the FAST series used in very high speed designs. 74HCT574 devices can be substituted for the ACT devices if necessary, but the HCT574 is not guaranteed to work at 40MHz.

ACT devices should be used instead of AC devices, as this provides compatibility for both CMOS and TTL inputs.

The 100k pull-up resistor on each input line is used to keep unused inputs from 'floating', which may cause undesirable effects. This also sets the effective value of the input resistance.

The latches capture the input data on the positive edge of the clock input, which is common to all four 8-bit latches. During sampling, the tri-state latches are permanently enabled by bringing the common enable line low. This also means that the RAM outputs must be disabled during sampling, otherwise both the latches and RAMs will be outputing data at the same time. To do this, the OUTPUT ENABLE line of the RAMs must be held high during sampling (the inverse of the latch enable line).

Writing the data into the RAMs is accomplished when the WRITE ENABLE line of the RAM is LOW. This must occur some time after the data has been latched, to allow for the propagation delay of the data through the latches. This is easily accomplished by tying the latch clock to the WE of the RAM. In this way, the data is latched and allowed to settle on the positive part of the clock, and then written into the RAM on the negative part of the clock.

During data retrieval the latch outputs are disabled (tri-state) and the RAM outputs enabled, which enables the data to be read back through the trigger LSI chips which are also connected to the data bus.

The SRAMs used here are the same 32KB cache RAMs as used on PC motherboards, so there should be little problem obtaining them at a very reasonable price. The RAMs should have an access time of 20ns or less. 25ns SRAMs have not been tried, but should work from looking at the data sheet.

The fourth section of the circuit is the power supply (Fig.1), which comprises a 2155-type 8.5V transformer whose output is full wave rectified by the WO4 diode bridge and filtered by C1. A 7805 regulator provides a regulated 5V at 500mA, as required by all of the digital circuitry.

The current consumption will depend on the brand of SRAMS used, as different types can range from 50-100mA or more per chip. A small finned TO-220 heatsink must be used for the regulator, to provide adequate heat dissipation. A larger heatsink may be required depending on the voltage at the input to the regulator.

The rest of the circuitry is contained within the three LSI chips (Fig.2), which we'll now look at more closely.

LSI control chip

The main control LSI (IC16) contains all of the control circuitry required to operate the PCLA. Most of the inputs to the LSI come directly from the PC, which has control over the functionality of the entire project.

The circuitry inside IC16 is shown in Fig.3, and can be broken down into six main functions :

1. Clock polarity selection, which is simply a two-input multiplexer which selects either CLKA or CLKB from IC5. The CLKSEL input comes straight from the PC. The output of the MUX (SCLK) provides the main sampling clock for the rest of the circuitry.
2. The trigger logic section, which does two things. The first is to select either the internal trigger from the trigger LSIs (EQ1 and EQ2), or the external trigger signal (EXTTRIG) from CN1. The TRIGSEL line from the PC is used to select either of those signals. AND gate A1 is used to combine the trigger signals from the two trigger chips, effectively creating a 32-channel AND gate. The MUX output is then fed into controlled inverter X2, a 2-input XOR gate. The trigger polarity signal (TRIGPOL) from the PC either inverts or buffers the TRIGOUT signal to always produce a positive-going master trigger signal called TRIG.
3. The trigger delay section. This takes the TRIG signal, along with SCLK, and can delay the trigger signal by 0, 2, 4 or 8 clock cycles. A 4-input MUX selects which of the four delay settings will be selected, using control lines TD0 and TD1 from the PC.

A delay of zero is chosen by just feeding the TRIG signal straight into the MUX. The other delay times are generated by a four-bit counter, which is incremented by SCLK only when the TRIG signal is active (HIGH) by virtue of AND gate A2. The counter is automatically reset when the TRIG line goes low, which restarts the delay counter ready for next time.

(The name TRIGGER DELAY is a bit deceiving, as the trigger signal is not always 'delayed'. If the trigger signal does not stay high for the duration of the delay time, then the trigger signal is ignored. This can be used to stop spurious signals from triggering the analyser.)

4. The RAM address counter, which as the name implies generates the address for all four of the RAM chips. It acts as a 15-bit circular counter, which means it never gets reset. This is to allow the data to slowly overwrite itself, which is needed to provide the PRE- and POST-trigger capability. The counter is of the synchronous type, which ensures that all of the outputs change at once.
5. The 15-bit post trigger counter, which is effectively a divide by 32,768 counter. The 15th output line goes high 16,384 counts after the trigger event,

Getting the PLDs and Software

The designers of this project have generously provided the internal coding for the PLD chips used in the design, for us to make available for readers wishing to program their own devices. The necessary files will be available on the EA Reader Service BBS for free downloading, and will also be available by mail for those who prefer to send a formatted HD 3.5" floppy disk, plus a cheque or money order for $7.50 (made out to Electronics Australia) to cover copying and return postage.

Alternatively, for those who prefer not to program their own chips, a set of three preprogrammed LSI1016 PLD devices will be available from Tronnort Technology, of 12 Copeland Road, Lethbridge Park NSW 2770. The set of three programmed chips is priced at $55 including postage.

Tronnort Technology can also supply the PC software needed to control and run the Logic Analyser, for only $35 including postage.

The software and programmed PLDs can be purchased together, for a discounted total cost of $80 including postage.

which stops any further sampling. This allows the RAM to be half filled with data before the trigger event, and half after the trigger event.

6. The main control logic, which coordinates all of the above sections to provide the functionality of the logic analyser.

To understand how it all works, let's start by assuming that the ARM control line from the PC is high. This resets the post trigger counter and the RS flip-flop, which we'll call the trigger latch. The SET input of the trigger latch is held low by inverter I2 and AND gate A3. The trigger latch will therefore ignore all trigger signals coming from the trigger delay section via the TMOUT line.

With the trigger latch held in the reset state, the Q output (TRIGLTCH) disables NAND gate N2, keeping the output (PCLK) high. Because the post trigger counter is not incrementing, the End Of Sample (EOS) line will never become high. This will allow the sample clock (SCLK) to pass through NAND gate N1.

Assuming that the PC is keeping the manual address increment line (INC) low, the GCLK signal is fed straight through XOR gate X1, supplying the sample clock to the RAM address counter and the RAM write line RAMWR.

What this all means is that when the PC keeps the ARM line high, the PCLA is continuously writing data into the RAM, overwriting any previous data once the RAM address wraps around to the start again.

The CLK line of the input latches is connected to the RAMWR line. This allows the data to be latched on the positive edge of this clock and written into the current address of the RAM on the negative half of the cycle.

The RAM will continue to be filled with data, and when the address counter reaches 32,767, it will just loop back to the first address and continue to overwrite the old data in the RAM. This is called PRE TRIGGER sampling, as all of the current data in the RAM is before (or PRE) the trigger point. Effectively, you (and the software) never know, nor care what the current RAM address is; all the software needs to know is that there are 32,768 addresses.

The PC must keep the ARM line HIGH long enough for the entire RAM to be filled. This is to ensure that no data is left in the RAM from a previous aquisition. The software handles this automatically when using internal sampling as it knows the sampling rate and can thus determine the delay needed.

But when using an external clock, the PC has no way to know the sample rate and just adds a delay of one second.

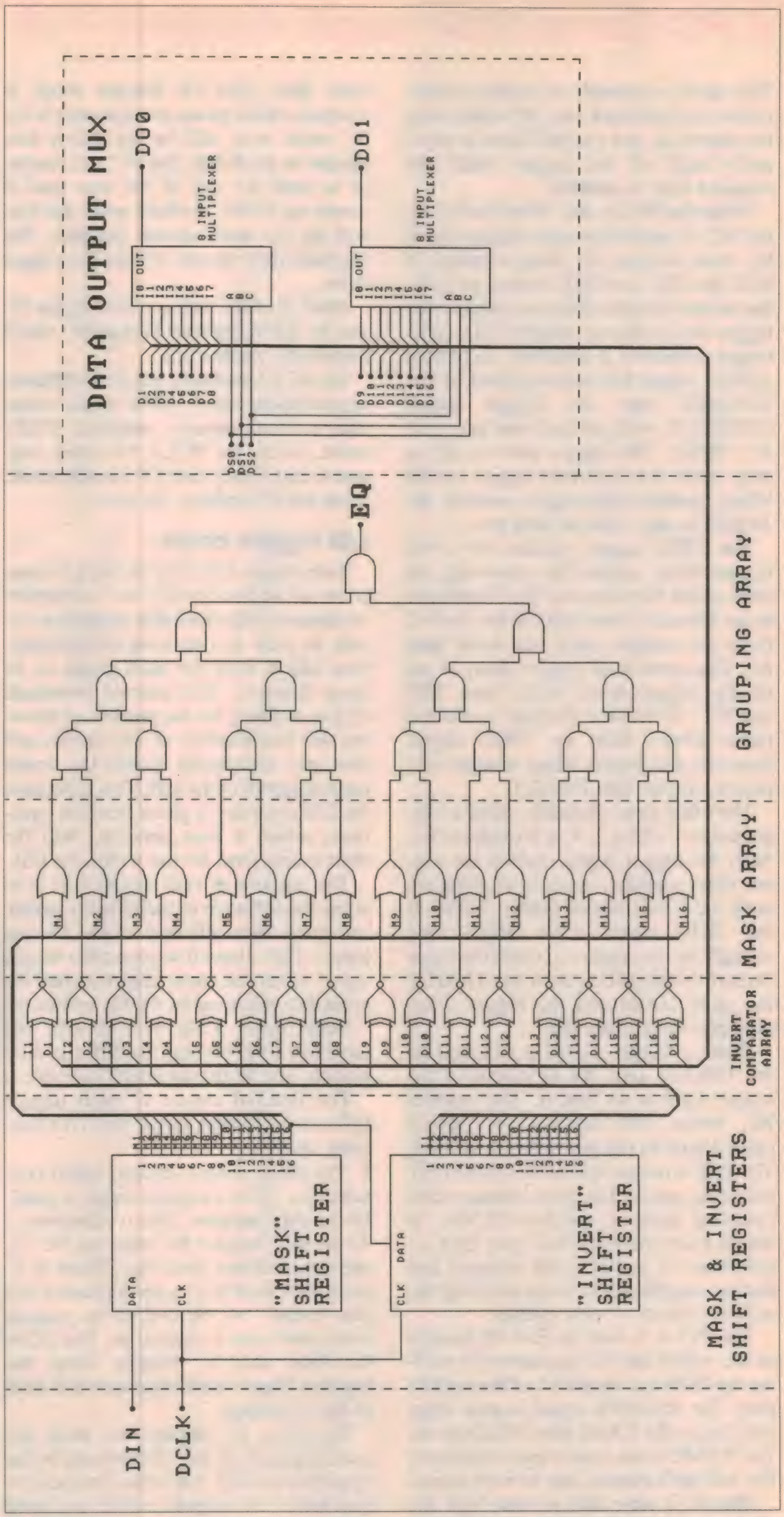


Fig.4: The circuitry inside each of the two trigger circuit PLAs (IC14 and IC15). Each chip provides a 16-channel fully maskable triggering circuit plus a pair of 8:1 data multiplexers, which are used to feed the sampled data back to the PC.

This delay is enough to handle a minimum external clock rate of 32kHz; any less than that, and you will have to manually hold off the trigger until the required time is reached.

When the PC sets the ARM line LOW, the PCLA can now accept a trigger signal by virtue of gate A3 being enabled. If both the EQ1 and EQ2 inputs go high, this means the input data has matched the trigger data in the two trigger LSIs, and a trigger condition is satisfied. Assuming internal trigger has been selected by the TRIGSEL line, the trigger signal (TRIGOUT) will go high and pass into A2 (TRIG). The trigger inverter X2 is only used for external trigger mode. When internal triggering is selected, the TRIGPOL line must be held low.

The TRIG signal enables the 4-bit trigger delay counter by removing the reset signal from inverter I3. The trigger delay counter is now able to be clocked from the sample clock via AND gate A2. The amount of trigger delay is set by the trigger delay MUX lines TD0 and TD1. If the first channel is selected (zero delay), then the TRIG signal bypasses the trigger delay counter and passes straight into TMOUT.

The other three channels select a trigger delay of either 2, 4, or 8 clock cycles. After the trigger signal enables the trigger delay counter, it starts to count up until the TRIG signal returns LOW. If the TRIG signal stays HIGH long enough for the counter to reach the value chosen by the MUX, then the TMOUT line goes HIGH and the trigger delay time period has been met.

When a trigger signal is received on the TMOUT line, the Q output of the trigger latch is set HIGH. This enables N2, which then supplies the sample clock signal to the post address counter. The PCLA is now said to be in the POST sampling mode. The post counter starts counting until it reaches 16,384, at which point the EOS line goes high — disabling N1 and N3, and stopping any further sample clocks from reaching the address counter or post counter.

The PCLA is now in End Of Sample mode, which the PC can detect by reading the EOS line on pin 15 of the parallel port. The RAMWR signal is now high, which puts the RAMs into READ mode. The RAMOE line is also low, which puts the data latch outputs into tri-state mode.

The PC is now able to read back the data from the RAMs, using the INC line to increment the RAM address counter. The RAM address counters are never reset when End Of Sample mode is reached, which means the first sample the PC reads back will be the oldest data sample in the RAM. The PC will continue to read the rest of the data until it counts to 32768, at which point the data will be the most recent sampled. The 16,384th data sample will be the trigger point.

After all of the data is retrieved, the PC sets the ARM line back high again, which restarts the whole cycle.

The PCLA therefore has three different modes of operation: ARM mode, where data is continuously sampled; POST mode, when the PCLA has been triggered; and finally End Of Sample mode, when the PC retrieves the data.

LSI trigger chips

Each trigger LSI chip (IC14, 15) comprises all of the circuitry for a complete 16-channel fully maskable triggering circuit, as well as two 8-bit multiplexers. One LSI is used for each group of 16 input channels. The internal schematic (Fig.4) is purely for the purpose of showing the functionality of the circuit, and does not necessarily match the actual internal layout of the LSI. This is because the LSI compiler is given Boolean equations, which it then generates into the most usable form for use within the LSI.

The purpose of each trigger LSI is to allow the software to individually invert, and mask (turn off) each of the 16 data inputs. This allows it to generate a trigger signal when the input data matches the exact data specified by the PC software.

Both trigger LSIs have exactly the same circuitry, but they do differ in their pinouts, and so are not interchangeable.

The internal circuit of each trigger LSI can be broken down into five separate sections:

1. The mask storage section, which contains two 16 bit cascaded serial-in parallel-out shift registers. This is effectively a 32-bit shift register fed from the PC via one data and one clock line. There is no need for a reset line, as the unwanted bits just 'vanish' off the end of the register when new data is pushed in. The PC is therefore able to directly write the required trigger mask information to each of the 32 outputs.

The first 16 outputs are used for masking each of the 16 channels in the sequence shown. Likewise for the second lot of 16 outputs, which are used for generating matching data for word comparison.

2. The invert comparators or word comparison circuit, which is simply 16 2-input exclusive-NOR gates, each of which acts as a 2-bit comparator. One XNOR gate is used for each of the 16 input channels. Input data is fed into one input of the XNOR gate (from the data lines, via the output MUX section) and the corresponding data line from the shift register is fed into the other input. If the data from the data register matches the input data, then XNOR gate will give a positive output. Likewise, if the register data does not match the input data, the XNOR output will be low. If all of the inputs match the 16-bit data on the data register outputs, then all of the XNOR outputs will be high, which signifies a match.

3. The masking array. Here the 16 channels from the comparator array are fed into 16 corresponding OR gates, along with the corresponding outputs of the mask shift register. This allows the PC software to individually mask out (or turn off) each of the 16 channels. A high output from the mask shift register will make the corresponding OR gate output high regardless of the data input. A low output from the mask register will allow the OR gate to pass the input data unaffected.

(Masking out a channel effectively 'matches' that input channel regardless of the incoming data. This allows the software to ignore certain input channels, and only trigger off the desired channels.)

4. The grouping array. This is effectively a 16-input AND gate, which generates a positive trigger signal EQ when all of the 16 channel inputs match the data register and/or are masked.

5. The data output MUX section. This final section comprises two 8-input multiplexers which are fed directly from the trigger LSI's data inputs (connected to the PCLA's internal data buses). The MUXes allow the PC to read back data captured in the RAMs. Each multiplexer handles 8 bits of data from its associated 16-bit data bus, and sends a single bit at a time directly back to the PC. Bit selection is handled by control lines DS0, DS1 and DS2, which come directly from the PC, and are common to both multiplexers.

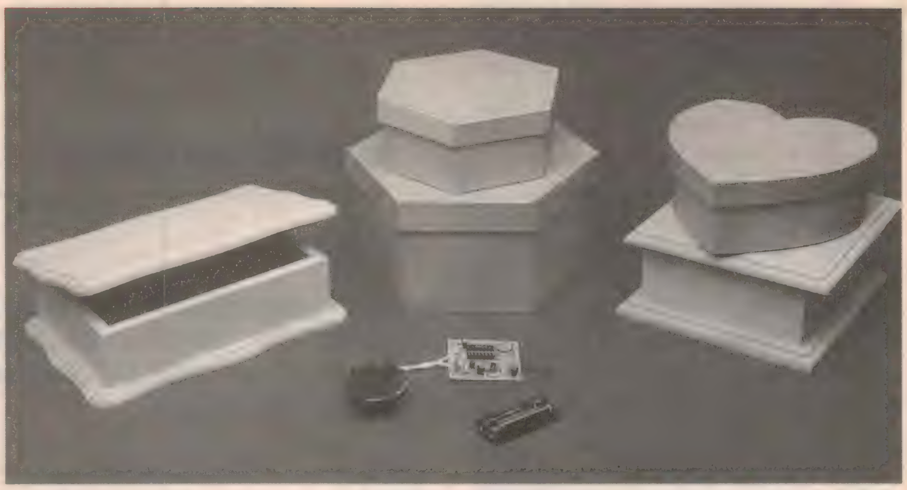
The four multiplexed data lines DO0-DO4 (two from each LSI) are fed directly back to the PC parallel port on pins 10, 11, 12 and 13. The software therefore retrieves one bit of data from four channels at the same time. Eight more read operations are required at the same address in order to read all 32 channels.

Hopefully the foregoing should give you a good idea of the way the new PC-Driven Logic Analyser works. In the second of these articles, we'll describe its construction and use.

(To be continued.) ❖

An Electronic 'Music Box'

(Continued from page 67)



A selection of suitable wooden and paper-mache boxes that Branco Justic of Oatley Electronics, the designer of the music box project, found at a local craft fair. Low in cost, boxes like these would be ideal for housing the project.

Putting it to use

About the only consideration for using this project is arranging it so the circuit is triggered by light falling on the LDR. In a box, you might put the circuitry under a false bottom, with a hole cut so light can reach the LDR when the lid of the box is opened.

In other applications, you could fit the LDR under a cover that is swung open to activate the circuit. Or you could fit a switch in place of the LDR. In this case, remove the LDR and fit a switch in its place. A pushbutton can also be used in place of the LDR. Here you might have the pushbutton arranged so it's released when the object is picked up, thus activating the music.

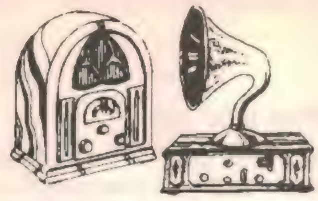
Remember too that there are two music ICs available, to give a wider variety of tunes. These can be purchased separately.

The PCB design has pin 3 (one/all tunes) and pin 5 (auto stop) connected to the supply rail. With this configuration, the IC will play the selected tune (via PB1) while the chip is enabled. If pin 3 is open circuit, the IC will cycle through all tunes while it's enabled.

The auto stop function is configured by connecting pin 5 to ground. To do this, cut the existing PCB track and solder a link from pin 5 to the ground (or negative) supply line. With this configuration, the IC can be triggered by the LDR, but rather than stop when the LDR is covered, the selected tune is played right through.

As you can see, it's a very flexible little unit. ❖

Vintage Radio



by ROGER JOHNSON

The Year that Was... 1923

For his first contribution to our Vintage Radio column, our new writer Roger Johnson has decided to give readers a 'snapshot' of a particular year — with particular emphasis on the development of Australia's fledgling radio industry. The year he's chosen is 1923, a particularly important one as it marked the official start of radio broadcasting.

1923 can be regarded as the year in which radio, or at least radio *broadcasting*, had become established in Australia. Just who can claim to have been the first broadcaster is really a matter of definition and debate. According to the late historian Phillip Geeves in his book *The Dawn of Australia's Radio Broadcasting*, although transmissions were carried out during the interval 1919-1922, it was quite clear to listeners, experimenters, dealers and the Government that by 1923 radio was here to stay.

Licences, 'sealed sets'

In 1923 everybody, it seems, was concerned with licences. Listeners paid a licence fee, as did experimenters, and in 1922 a further category was established for the 'Broadcasting Station'. This fee was set at five pounds per annum. In addition, dealers paid a licence fee to parent companies for the purpose of incorporating patents, where applicable, in the receiving sets that they sold.

At a conference in Melbourne in May 1923, there was unanimous adoption of a proposal by AWA's E.T. Fisk, later to be known as the 'sealed set' scheme. It was argued by Fisk and other notables from within the industry that those who purchased a wireless set should contribute to the cost of providing the transmission, via their licence fee, and that only those listeners who paid the fee could and should receive a transmission from the particular broadcaster to whom the fee was paid.

Some sample copies of Australia's Wireless Weekly magazine from 1923. The ancestor of this very magazine, it sold then for three pence a copy.

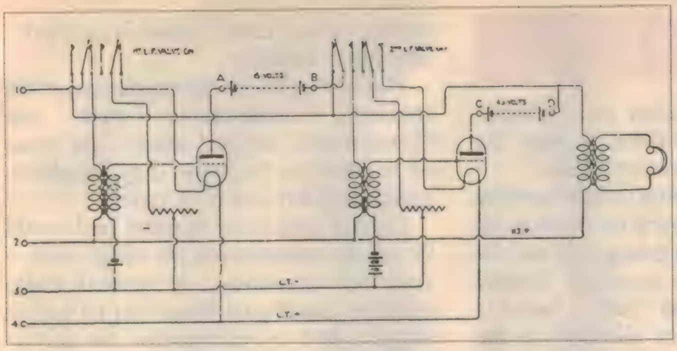
The way to ensure this state of affairs was to sell a receiver supposedly pretuned and 'sealed', to receive only the given broadcaster's wavelength. Any listener who wanted to listen to more than one station would be obliged to purchase another receiver, duly licensed and 'sealed' to the appropriate wavelength!

Not surprisingly the scheme was short lived. Anyone with the most rudimentary knowledge of radio was able to modify their sets to receive the full frequency range. Not only this, but anyone who purchased components was able to assemble their own set and overcome the restriction...

Radio magazines

It is difficult to imagine the interior of a 1923 newsagent, if indeed there was such a thing. But it is a pretty safe

A 'Gec-O-Phone' model BC 2001. Officially listed as the 1922 model in the UK, a few of these sets made their way to Australia. It is unusual in that it has an RF amplifier and detector only. A separate two-valve audio amplfier could be purchased if desired.



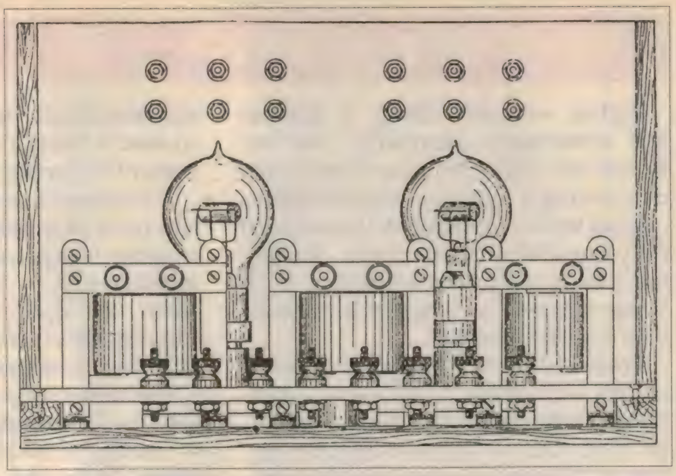


Fig.2: A typical circuit and panel layout for a receiver designed for the home constructor, taken from Wireless Weekly for August 24, 1923. Great emphasis was placed on a symmetrical layout.

bet that there may have been but 10-20% of the number of magazine titles on offer today. Amongst the magazines and periodicals dealing specifically with radio which were on offer were the Australian produced *Wireless Weekly*, founded by W.J. MacLardy in 1922, and imported titles such as the weeklies *Amateur Wireless and Electrics* and *Popular Wireless* from the United Kingdom, and the monthlies *Radio News* and *Radio* from the United States. The American monthlies had a US cover price of 25 cents, and apparently sold here for 1/9 or 2/- Australian (18c or 20c in modern parlance).

Just what did these publications contain?

Well, *Radio News* was a superior production, with around 160 pages of almost A4 size on quality paper. Advertising featured very heavily indeed, particularly for 'factory built' radios. Brand names which are household words to vintage radio collectors, are there in abundance. Brands such as Grebe, Atwater Kent, Crosley and Radiola command full page advertisements.

There is also the run of educational and technical articles, with question and answer pages and of course quite detailed articles on set construction. One description is of a superhet with seven valves, but using one tunable intermediate frequency stage, and a five-stage resistance coupled audio amplifier. The mind boggles!

The English weeklies were of a similar page size but consisted of 28 pages. Advertisements were not quite so plentiful. There were some quite good photographic reproductions.

Australia's *Wireless Weekly* was quite modest by comparison, comprising 20 pages measuring only 7-3/8" x 9-5/8". The occasional photograph or two are mainly those of advertised items. There was news of radio clubs, and discussion of where the industry was heading (see cartoon in Fig.1). Other popular items were concerned with caring for your apparatus: e.g., 'Don't burn your thoriated filament tubes too brightly — the correct current for a C301a or the UV201a is 1/4 ampere'. In the same issue there's also 'a talk on the care of the telephone'.

The articles on home construction had great emphasis on symmetry and geometry of the front panel layout, and also the component parts (Fig.2). The casual observer could be forgiven for mistaking the illustrations to be an exercise in line drawing and draughting techniques, rather than radio building.

There were of course a liberal sprinkling of advertisements, which are rather essential for research and identification purposes. Notable by their absence, though, were advertisements for complete sets!

Radio receivers

In Australia in 1923 it certainly appears that the only factory built radio sets were imported. In fact, a feature photograph in *Wireless Weekly* for September 7, 1923 has the caption 'MAKING BROADCAST SETS: An industry about to commence in Australia'. The photo shows young women in long pinafores assembling Marconiphone V2's.

Brands such as Crosley, Atwater Kent, RCA Radiola and Grebe from the US; Stirling, Gec-O-Phone and Brown from the UK; and Telefunken and Siemens from Europe do date back to 1923, but genuine surviving examples are rare and highly prized.

Fig.2: This cartoon commenting on the current status of Australia's radio industry appeared in the September 7, 1923 issue of Wireless Weekly. The politicians seemed to be more interested in imposing a licensing system...

Radios were not cheap. A popular and economical alternative was the crystal set. However, even these could cost a week's wages, with headphones costing half as much again if purchased fully assembled from a dealer. Tuning, such as it was, was invariably by a 'loose coupler' or a tapped inductance with a fixed capacitor.

There is little doubt that many crystal sets were home made, using a variety of makeshift components such as 50 or 60 turns of bell wire tapped every five or 10 turns wound around a cardboard cocoa 'tin'. Often a razorblade and a nail were used for a makeshift detector, with capacitors made from interleaving layers of tinfoil and wax-dipped tissue paper, and the 'receiver' being an earpiece from a telephone.

It seems that valve radios, whether factory built or home assembled, were of the one, two or three valve variety consisting of a single tuned detector stage followed by one or two stages of transformer-coupled audio. One and two valve amplifiers for crystal sets were also popular.

Variometers featured heavily in 1923. These consisted of two coils, with one mounted inside the other on a spindle, so that it could be rotated to vary the inductive coupling between them.

If a set used it, reaction or regeneration was most likely achieved by varying the coupling between the tuning coil and the reaction coil — the so-called 'double tuner'. A 'triple tuner' had a variably coupled aerial coil in addition to the other two mentioned coils.

The valves used were more likely than not the 'bright emitters'. These valves — triodes of course — had a filament which lit up like a motorcar tail light bulb. The voltage was generally three or four volts and the current 0.4 - 0.8 amps, with a mu (amplification factor) of about 10 and a gm (transconductance) of in the vicinity of 500 micromhos (500uA/V, or 500uS). The so called 'dull emitters' such as the 201a, etc., were being advertised, but at a cost of twice that of the bright emitters.

Summarising 1923

It is difficult to provide either absolute accuracy or great detail in so short a space, but hopefully this snapshot of the year 1923 has given you a feel for where things stood in the fledgling radio industry.

There was lively debate amongst the industry, consumers and the Government, centred around the issue of licences — to whom they should be paid, for what and how much.

Crystal sets were popular and could be easily constructed by those with a flair for invention. A typical radio receiver could cost from 3 to 10 weeks wages; had a variometer or multi-tapped coil with a stud switch on the panel; one, two or three bright emitter valves and filament rheostats of 2 ohms to 5 ohms, one for each valve. The front panel was often more square than oblong in frontal appearance.

Radio transmissions from 'broadcasters', only lasted for a couple of hours at a time, with three or four daily sessions. Broadcast stations as we know them today were few and far between, with perhaps half a dozen only in the mainland states. Many broadcasters were radio amateurs, transmitting from the living room of their homes on about 10 watts for a couple of hours per week, and their contribution to broadcasting in those early days cannot be underestimated — particularly in terms of providing entertainment ❖

NOTES & ERRATA

Stroboscopic Tuner (May 1996): The values for R1 and R2 were transposed in the component overlay diagram, on page 67 — R1 should be 1.5M and R2 should be 820k.

If you are having problems with the sensitivity of the microphone input, try checking that these resistors are installed correctly.

The circuit diagram and parts list are correct.

Also transposed were the 6V battery connections shown on the overlay diagram; the battery should be connected with positive going to the positive side of C9. ❖

NEW KITS FOR EA PROJECTS

From Dick Smith Electronics:

Low Cost RF Test Oscillator (May/June 1996): The DSE kit is complete with all components as described, PC boards, case with pre-punched and silk screened front panel, and including a red perspex filter for the frequency display.

Listed as Cat. No. K-7343, it is priced at $189.00.

Upconverter for the Spectrum Analyser (September 1996): The DSE kit is of the short-form type, with the PCB and all components only (including the balanced mixer and VCO modules).

Listed as Cat. No. K-7621, it is priced at $79.50.

IR Remote Volume for the 50W/Ch Stereo Amp (September 1996): This exclusive DSE kit includes the complete transmitter and all parts to make the receiver module — including PCB and motorised stereo volume control pot assembly.

Listed as K-5591, it is priced at $39.50.

From Jaycar Electronics:

PC Bus Sleuth (October 1996): The Jaycar kit is complete and includes both PCBs, all components, ribbon cable and IDC connectors, plus bonus sockets for all ICs.

Listed as KA-1788, it is priced at $34.95.

This information is published in good faith, from advice provided by the firms concerned, and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions. ❖

THE CHALLIS REPORT

(Continued from page 13)

Reference Series Disc (10063-2-F). This disc contains superb transients and exciting music from both the violin and the piano. We simply could not pick the difference between the original and the copy.

We progressed to a third test disc, which I have previously used, featuring Yo-Yo Ma and Bobby McFerrin in 'Hush' (Sony Masterworks SK48177). For the comparison however, I used a Sony Masterworks pre-recorded MiniDisc (SM48177), incorporating the identical tracks. Again my test panel were unable to pick which was the CD or the MiniDisc, and my esteem for the new MiniDisc deck incremented by yet another notch.

The last disc which I recorded was Ludwig Van Beethoven's 'Works for Chorus and Orchestra' (Koch Schwann 3-1485-2). This disc provided us with some excellent choral material, and although the individual voices were less effective in terms of vocal identification, we were still able to draw the same conclusion — namely that we could not tell the difference between the original CD and the copied tracks on the MiniDisc.

Each of these discs contained superb musical content, and epitomised the wide band vocal, musical and transient test signals which tested our hearing and our discrimination, as well as the equipment, whilst performing multiple direct A-B/A-B inter-comparison tests. Those tests used a time lag between CD player and MiniDisc player of three seconds, so that we could repetitively switch from one source to the other, and hear precisely the same material.

We ran this A-B testing during two separate sessions encompassing a total period of three hours. After the testing was completed we were satisfied that we could neither identify, nor could we hear any difference between the digital original and the digitally recorded MiniDisc, or the manufacturer's own pre-recorded version of that same disc.

After carrying out numerous additional recordings of my own (on my own), I came to the conclusion that the JA3ES is currently the most convenient, and outstanding digital audio recorder (deck) that I have ever had the pleasure to use, or to audition.

With a selling price of $1999 it is certainly not cheap. However, when I review its performance, its convenience and its special capabilities, and most particularly that magical six seconds of pre-recording time capability, this is undoubtedly the most outstanding music and consumer recorder that I have ever used.

The Sony MDS-JA3ES MiniDisc Recorder Deck measures 430 x 345 x 125mm (W x D x H), and weighs 6kg. It comes with a IR remote control unit (RM-D2M), operator's manual and cables.

Further information is available from the Consumer Products Group, Sony Australia, PO Box 377, North Ryde 2113; phone (02) 9887 6666 or fax (02) 9887 4351. ❖

PC BUS SLEUTH

(Continued from page 60)

These LEDs indicate the actual IRQ/DMA lines that are used by that particular card.

6. Switch off the computer, remove the card, and repeat steps 4 and 5 for any remaining cards.

You will now have a list of the IRQ and DMA assignments for each card in your computer. Armed with this list, you should be able to spot any conflicts in the IRQ/DMA lines. It should now be a simple matter to set one of the offending cards to an unused IRQ/DMA control line, using either jumpers on the card or a software setup program designed for that specific device. Once any conflicts are cleared up, it's a good idea to verify that any command line parameters specifying IRQs or DMAs in the CONFIG.SYS or AUTOEXEC.BAT files are correct, and reflect the settings on each card as well.

If a card contains a forest of jumpers, and you don't know which ones are for setting the IRQs or DMAs, the diagram in Fig.1 could come in handy. Simply line up the card's edge connector with the diagram, and you should be able to trace quickly the IRQ and DMA contacts back to their jumpers. Knowing which jumpers connect to these control lines can save you an awful lot of time. You can now try some likely jumper settings, and check them against the results from the Sleuth.

Once you have everything up and running correctly, why not leave the Sleuth installed in your machine, as it can give you a fascinating insight into its inner workings. ❖

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Amidon Ferromagnetic Cores: For all RF applications. Send business size SASE for data/price to RJ&US Imports, Box 431, Kiama NSW 2533. Agencies at Geoff Wood Electronics, Sydney; Webb Electronics, Albury; Assoc TV Service, Hobart; Truscotts Electronic World, Melbourne and Mildura; Alpha Tango Products, Perth; Haven Electronics, Nowra: WIA Equipment Supplies, Adelaide.

Satellite Dishes: International reception of Intelsat, Panamsat, Gorizont, Rimsat. Warehouse sale – 4.6m Dish & pole $1499, LNB $50, feed $75. All accessories available. Videosat, 2/28 Salisbury Rd. Hornsby. (02) 9482 3100 8.30-5.00 M-F.

PCB's made, one or many, low prices, hobbyists welcome. Also Touch Switch for lamps, 2A, 3 steps, $7 ea.plus P+H $3 for 3 units. Sesame Electronics (02) 554-9760, Fax (02) 9718-4762.

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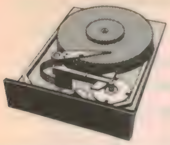
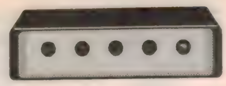


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Wanted: Geloso A.M.H.F. Transmitter Amateur Bands any condition. Also WW II Command Series Transmitters and Receivers, FS6, 101, No11 Sets with or without power supplies. AVO Valve Tester prepared to pay Top Money, P.O. Box 275 Ferny Hills Brisbane 4054 Ray (07) 3299 3819

Wanted: Simple secondhand oscilloscope in good condition, E.G.Early BWD. Call John 087 334445

Wanted Circuit of Silver Stereo Model SS171 Box 535 Geraldton 6531

Computer Programming Whiz! to create modules of code. DOS. W95. Pls fax details rates. 09 344 5905

NOTICES

Vintage Radio Swap Meet:
Sunday October 20th 1996. Glenroy Tech School Hall Melbourne, Victoria. Melway Ref Map 16. K. 2. Admission $3. Inquiries (054) 493 207

50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Here we feature some items from past issues.

October 1946

New Valves in Tiny Pocket Radio: The heart of the smallest radio receiving set being commercially produced is the postwar development of the valve that made possible the amazing performance of the VT fuse. Details concerning these sub-miniature valves, only 1-9/16" long, have been released by Raytheon Manufacturing Co., Newton, Mass.

The five plug-in valves used in the new pocket radio weigh about a half-ounce, occupy less than a cubic inch total volume, and perform all the functions of normal size valves found in conventional superheterodyne radios. Each valve in the series has the same physical dimensions, measuring 1-9/16" x .400" x .300", or approximately the cross-sectional area of an oval cigarette. Yet one of them, the converter, has nine active surfaces between the two glass walls which are only one-quarter inch apart.

Newspaper by Radio: Facsimile transmission of a newspaper by radio is about to become an accomplished fact for residents of Atlanta, USA. The Atlanta (Georgia) Journal will soon commence the use of their radio station to transmit a four-page facsimile newspaper. Approximately 15 minutes is the estimated time for the transmission of the complete newspaper, which will carry pictures.

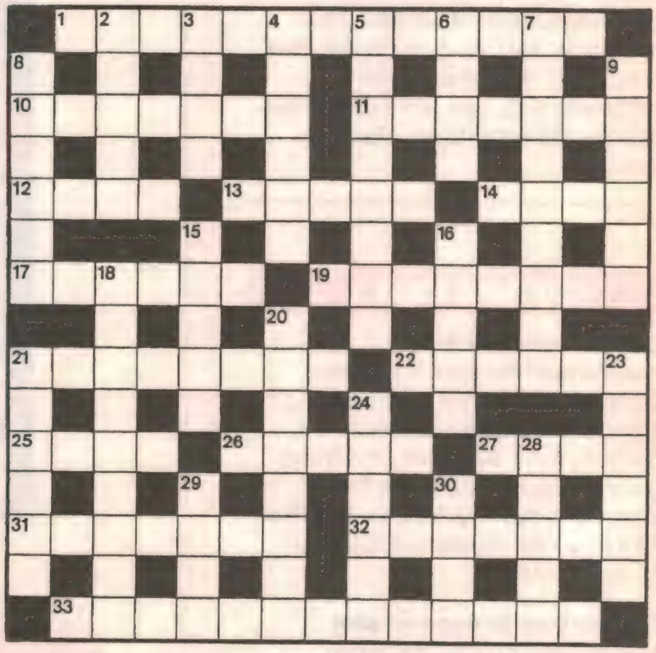
October 1971

Omega Navigation: Litton Industries has delivered to the US Navy the first of eight Omega radio transmitters that will eventually provide a worldwide, all-weather navigational network for ships and aircraft of all nations. It is expected that, with the aid of Omega, a ship or aircraft will be able to determine its position to within one or two miles. The first Omega transmitter will be installed at LaMoure, North Dakota USA. Additional transmitters will be established in Australia, Japan, Hawaii, Trinidad, Norway, Argentina and Reunion. The US Government will provide the electronic equipment for all stations which will be operated by host nations.

Reducing Telegraph Errors: A new telegraph error correcting system, costing no more than earlier generations, but with increased performance and facilities providing a tenfold increase in accuracy, has been introduced in the UK by Marconi Communication Systems. The system, designated Autospec II, employs high speed microcircuits, and occupies half the space of earlier equipment. It will allow forward error correction to be effectively applied, for the first time, to telex circuits.

The equipment operates by recoding the normal, coded telegraph signals in such a way that most errors can be detected and then automatically corrected at the receiving end, without the necessity of checking with the transmitting station. ❖

EA CROSSWORD



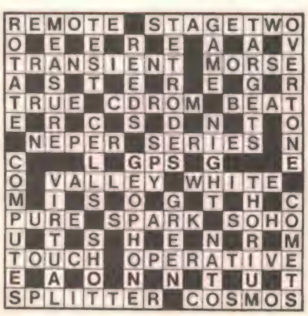
ACROSS

1 Visual programs (at a price). (3,10)
10 Measure of the state of disorder. (7)
11 Said of a dual lens system. (7)
12 Transmit. (4)
13 Foot control. (5)
14 Alternative state to flip. (4)
17 Most secure. (6)
19 Available audience, etc. (8)
21 Burglar alarm, or .... system. (8)
22 Number to be included in sum. (6)
25 Australian record industry association. (4)
26 Computer problem. (5)
27 Programmable memory. (4)
31 Position for certain electric fans. (7)
32 Axle. (7)
33 Apparatus for finding covered objects. (5,8)

DOWN

2 Name of dark space in discharge tube. (5)
3 Implement. (4)
4 Old-fashioned capacitor, the .... jar. (6)
5 Device that oscillates. (8)
6 Said of low energy x-rays. (4)
7 Fluctuate back and forth. (9)
8 Optical components. (6)
9 Undergo a passage of time. (6)
15 Australian research body. (1,1,1,1,1)
16 Connecting conductors. (5)
18 Electronic message that duplicates. (9)
20 Said of wired instruments (8)
21 Look for information. (6)
23 Light control. (6)
24 Part of a larger group. (6)
28 Section of the e/m spectrum. (5)
29 Insulating mineral. (4)
30 Component of a dry cell. (4)

SOLUTION TO SEPTEMBER 1996:



Electronics Australia's

Professional Electronics

SUPPLEMENT

TEKTRONIX LAUNCHES NEW RANGE OF VERY COMPACT AND AGGRESSIVELY PRICED 1GS/s DRT SAMPLING SCOPES

DICK SMITH ELECTRONICS OPENS 'POWERHOUSE' STORE

NICKEL-METAL HYDRIDE CELL TECHNOLOGY MOVES AHEAD

A LOOK AT THE LATEST TEST & MEASURING INSTRUMENTS

NEW RANGE OF LOW COST, WIDE BANDWIDTH MONOLITHIC MICROWAVE IC AMPLIFIERS FROM MINI-CIRCUITS INC., BASED ON HETERO-JUNCTION BIPOLAR TECHNOLOGY, OFFERS USEFUL GAIN PAST 8GHZ...

Available in Australia from Clarke & Severn Electronics:

http:\\www.buynet.com.au

NEWS HIGHLIGHTS

TEK LAUNCHES LOW COST RANGE OF REAL-TIME DSO'S

As seen here the new Tektronix TDS 200 may look fairly conventional — but unlike most analog scopes or DSO's, it's only 110mm deep and weighs a mere 6.4kg. It also offers 1GHz real-time sampling, at a highly competitive price.

Celebrating its 50th Anniversary this year, Tektronix Inc has long been a world market leader in oscilloscopes, especially at the professional end of the market. However the company has now launched a range of aggressively priced desktop/portable digital instruments which look set to make a dramatic impact on the economy end of the market, still largely dominated by low cost analog instruments from Asian manufacturers.

The new TDS 200 Series instruments offer four key attributes: low price, superior measurement capability, a dramatic reduction in size, and friendly analog-like controls and operating modes. They measure a very compact 305 x 151 x 110mm (W x H x D) — about the size of a shoebox — and weigh only 2.9kg (6.4lb).

Crucially, the TDS 210 and TDS 220 break down the price barriers that historically have forced price-driven scope buyers to choose analog scopes. Until now, digital scopes have cost about twice as much as similarly-equipped analog units. The TDS 200 Series sets a new price standard: both models are priced lower than the majority of their competitors — analog or digital. The 100MHz TDS 220, for example, is being launched at $1995 plus sales tax, much less than other current 100MHz DSO's and directly competitive with 100MHz analog scopes. The 60MHz TDS 210 is priced at only $1395 plus tax. (Both models are dual channel.)

Tek stresses that neither performance nor technical features have been sacrificed in achieving these levels of compactness and lower cost. The new scopes rely on the company's proven Digital Real-Time (DRT) oversampling technology to provide impressive waveform quality, display update rate, and stability. Both models sample in real time at 1GS/s, at least 10 times their bandwidth. This advanced high-speed technology enables users to capture signal details invisible on analog scopes. Simply stated, DRT samples fast enough to reconstruct high speed signal edges and transients with unmatched clarity.

Unlike most of the analog scopes they'll compete with, the TDS 210 and TDS 220 are equipped with pre-programmed automatic measurements that allow users to quantify waveforms quickly: period, frequency, cycle RMS, mean, and peak-to-peak. Other productivity features include automatic setups (similar to autoranging on a digital multimeter), stored reference waveforms, and stored front panel setups which are not lost when the power is turned off.

The TDS 210 and TDS 220 also bring back many of the front panel knobs so familiar to analog scope users. Routine functions — gain, sweep speed, vertical/horizontal positioning, and others — are immediately accessible and respond like analog scope controls. Automated digital functions are controlled by a simplified menu system on the display screen.

The TDS 200 Series' menus are in fact available in 10 languages, permanently stored onboard and user-selectable. This feature frees users from having to interpret English commands, which in turn makes the scopes faster to use and less prone to errors.

The TDS 200 Series' screen is a bright, high-contrast backlit liquid crystal display (LCD) with a wide viewing angle. Unlike analog scope displays, the LCD maintains full contrast at all sweep speeds and gain settings. Any signal that triggers the TDS 210 or TDS 220 will be clearly visible on the screen.

Optional low cost Centronics parallel printer port or GPIB/RS-232 communications port modules are available for the new models.

FREE DESIGNER GUIDE FOR MINI-CIRCUITS RF MODULES

To encourage radio amateurs and experimenters to build and develop their own communications equipment, Mini-Circuits USA are offering, free of charge, their *RF/IF Designer's Guide*.

Mini-Circuits manufacture an extensive range of mini-modules such as RF amplifiers, frequency mixers, power splitters, VCO's, filters, detectors, attenuators, etc. Circuits are available in various case style packages to suit applications from surface mount to external equipment mounts. Typical mixer frequency ranges from 10kHz to 4.3GHz, making them ideal for engineers interested in LF to SHF work.

If you would like a free copy of the *RF/IF Designer's Guide*, contact Mini Circuits' Australian representatives and stockists Clarke & Severn Electronics, of PO Box 1, Hornsby NSW 2077, or call (02) 9482 1944.

Shaped like an oversize gyroscope, this new wind generator was exhibited at the recent Leipzig Fair in Germany. Designed by the German firm Heynck, in Bocholt, it operates very quietly and can produce up to 12kW of power. (Inter Nationes)

BANKSIA TECHNOLOGY ACQUIRES DATAPLEX

Banksia Technology, one of Australia's fastest growing private companies, has announced the acquisition of Dataplex Pty Ltd, a major manufacturer of professional data communications solutions.

Dataplex will be run as an independent business unit and retain its company name, product brand names and individual identity. Banksia will however assume total management control.

Mr David Stewart, Banksia's Managing Director, said: "We aim to preserve Dataplex's successful company culture. Dataplex will continue to operate as a standalone organisation, maintaining its successful business focus and selling methods."

The move follows Banksia's recent acquisition of Simplecomputing Pty Ltd, a growing Sydney-based manufacturer of modems for the retail market.

According to David Stewart, the acquisition of Dataplex creates a powerful, multi-tiered organisation able to provide high-quality communications products to the entire market spectrum.

"Dataplex enjoys a strong reputation as a corporate solutions provider. This dovetails perfectly with Banksia's position as a leading modem manufacturer and supplier to the reseller channel and Simplecomputing's strength in the high-volume, mass market sector", he said.

DICK SMITH ELECTRONICS OPENS 'POWERHOUSE' STORE

Dick Smith Electronics has opened the first of a planned new series of 'PowerHouse' concept stores, in the Sydney suburb of Bankstown. Over 12 months in planning, the new store measures a spacious 2000 square metres — between six and eight times larger than typical existing Dick Smith Electronics stores.

Divided into five specialty areas (Communications, Computers, Music, Electronics and Entertainment), the PowerHouse boasts a range of over 20,000 products including camcorders, cameras, TV receivers, VCRs, compact discs and many other additions to the Company's traditional product range. Also all products on display allow for complete hands-on demonstration, thanks to the store's purpose-built design.

Features include a fully functioning home office setting where customers can try out computers, printers and fax machines before they buy; a complete home theatre demonstration area where customers can compare any combination of surround sound speakers, while watching their favourite movie on a widescreen TV; a Ham Radio Shack, where amateur radio enthusiasts can try out communications gear 'on the air'; a music bar, where music lovers can listen to CDs before buying; an Internet Bar, for customers to explore the 'net and Web; a Telstra Kiosk, able to demonstrate mobile phones, fax and data, and also Foxtel Pay TV; and an On-Site Technical Service Centre, where computers can be upgraded on the spot and other products can be serviced.

There's also a fitting bay for car radios and mobile phones, a play area for young children and even a technical data library for 'serious' electronics customers.

Bright, open and friendly, and with extremely competitive pricing as well as knowledgeable sales staff, the Dick Smith Electronics PowerHouse is a significant step for the All-Australian retailer — but one that the Company believes will gain acceptance.

The new store is located at the Christies Home Centre, 173 Canterbury Road (Cnr Chapel Road), Bankstown.

TELECOMMS EXPORTS SURGE TO $1B IN 1995

Australian exports of telecommunications equipment exceeded $1 billion in 1995 despite a slowing in the growth rate of industry production, commented Alex Gosman, Executive Director, ATIA following the release of the Association's members survey for 1995. (The survey covers sales, R&D, exports and employment.)

Despite difficult and worsening general economic conditions, the telecommunications industry continued to be the star manufacturing sector, with annual export growth over the past five years of 33% and annual R&D of nearly $300 million (in excess of 6% of industry turnover (compared with 1% for manufacturing generally). Overall production grew by 5% in 1995.

The telecommunications industry's exports account for over 40% of the exports of the Australian information industries in 1995, with typical levels of Australian content in excess of 70%.

The industry's export/import ratio has improved by over 100% in the past three years, and it remains the only sector of the information industry in which Australia has a significant manufacturing presence.

"Much of the success of the industry can be attributed to the policy approaches applying to the industry, notably the Partnerships for Development and the Industry

Development Commitments applying to the carriers", commented Alex Gosman. "In addition general policies such as the R&D concession, EMDG and computer bounty have been of great assistance. These measures have encouraged increased investment and exports and the developments of strategic alliances across the industry."

DSTO DEVELOPS NEW COMPUTER SECURITY SYSTEM

The Minister for Defence Industry, Science and Personnel, Mrs Bronwyn Bishop, has announced the selection of a consortium to develop an Australian computer security system which will offer unprecedented protection of sensitive information in defence and commercial environments.

Believed to be a world first, the system, known as Starlight was developed by the Defence Science and Technology Organisation's (DSTO) Information Technology Division at Salisbury, South Australia.

The successful consortium consists of Vision Abell Pty Ltd, BHP IT Ltd, Compucat Pty Ltd and Digital Equipment Corporation.

DATAWATCH TO MARKET VET IN NORTH AMERICA

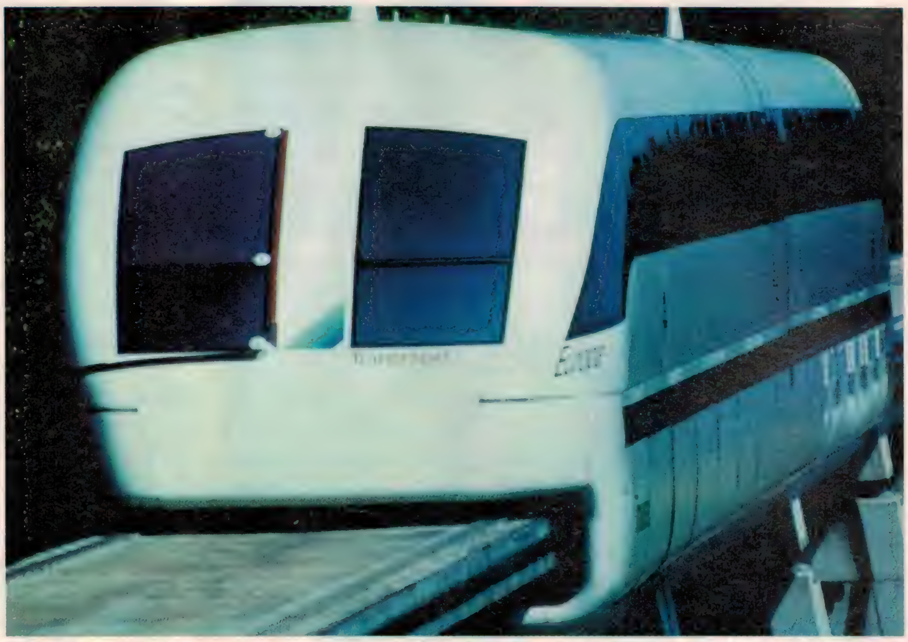
Melbourne-based Cybec Pty Ltd, makers of VET Anti-Virus Software, has announced an exclusive agreement with US company Datawatch Corporation, to market VET software in the United States and Canada. Datawatch developed and markets Virex, anti-virus protection for Macintosh computers and a number of other IT products.

VET is already used on over 300,000 PCs in 33 countries, by businesses, government, education and home users, while Virex is the market leader for Macintosh computers.

Datawatch began shipping VET software in September.

PHILIPS & SONY LICENSE WEBTV TECHNOLOGY

WebTV Networks, Inc. has announced licensing agreements with consumer electronics industry leaders Sony Electronics Inc. and Philips Consumer Electronics Company. These are the first electronics companies to work with WebTV Networks in bringing high-quality, economical Internet access to the television consumer audience.



This Transrapid magnetic suspension train will ply between Berlin and Hamburg within a few years. Thyssen and Siemens are the prime contractors, and the 280km trip will take less than an hour. (Inter Nationes)

WebTV Networks is licensing its Reference Design suite of technologies to Philips and Sony for incorporation into set-top boxes. Philips and Sony plan to announce specific product information later this summer.

"Home electronics powerhouses like Philips and Sony are central to leveraging WebTV Networks' expertise and intellectual assets for the benefit of a broad consumer market", said Steve Periman, WebTV Networks' president and CEO. "Both companies will add considerable value to WebTV's technical foundation, with their keen market perspective, proven knowledge of how to make advanced technology accessible to consumers, and substantial resources for development, production and distribution of new products."

NEW GROUPING FOR ELECTRONICS ASSEMBLERS

The AEEMA has established a new grouping, the Australian Electronic Assemblers Association (AEAA) to represent the Australian electronics assemblers industry. This is in recognition of this rapidly growing segment of the industry and the current lack of any representative body for the industry, according to Executive Director Alex Gosman.

"The assembler/sub-contract industry is estimated to have a turnover of over $120 million in Australia, employs over 900 people and is growing at 40% annually. In the US it is the most rapidly expanding sector of the electronics industry."

"The new AEAA will focus on promoting the development of a technologically advanced and viable electronics assembly industry in Australia through a combination of 'lobbying' activities as well as self-help initiatives."

Over 10 companies have attended the first two informal meetings, chaired by Hugh Kelly of AEMS. Expressions of support from an additional 7-8 companies have been received.

EXTENDED TRADING AT RIE'S MELBOURNE STORE

Rod Irving Electronics has extended the trading hours for its store at 48 A'Becket Street, Melbourne. The store is now open from 8.30am to 5.30pm Monday - Thursday, 8.30am to 8.00pm Friday, 9.00am to 5.00pm Saturday and 10.00am to 5.00pm on Sunday.

RIE is also running its computer and Internet training courses at the store on Tuesday and Friday nights. The fees are a moderate $25 per person for a three hour training session. Other courses are

planned for the future. Further information is available from RIE's World Wide Web site at **http://www.ozemail.com.au/~rie**, or by e-mail from **rie@ozemail.com.au**.

SIEMENS WINS $430M INDONESIAN PHONE ORDER

Over the next three years the Siemens Public Communication Networks Group, as general contractor, will be installing more than 400,000 telephone lines for expanding the telecommunications infrastructure in Indonesia. Siemens is setting up a complete network for the private Indonesian network operator PT. Bukaka SingTel International (BSI), including access, switching and transmission technology, supplying and laying fibre optic cable and the network management.

The turnkey implementation of this large project, worth over 500 million Deutchmarks (A$430 million) is being handled by Siemens' newly-formed Network Engineering Business Unit.

Indonesia has around 190 million inhabitants, but only 2.4 million telephones. This corresponds to a telephone density of around one telephone per 100 inhabitants (compared to Australia with a density of over 50 telephones per 100 inhabitants).

PHILIPS LAUNCHES NEW MOBILE PHONES

Philips Consumer Communications has launched a new range of highly featured, competitively priced digital mobile phones targeted at the consumer market. Stylish design and an intuitive user interface combined with high performance are intended to make the new 'Philips Fizz' phones an attractive proposition for consumers looking for value, reliability and a recognised brand. They are also designed to appeal to business and SOHO users looking for a performance mobile phone capable of using some of the best features offered by the digital networks.

Available in a range of design and colour combinations, Fizz phones are ultra-slim at only 17mm thick, making them ideal for jacket and shirt pockets. They weigh in at just 210 grams, fitted with the standard battery.

There are three battery options and three car kits, including a fully featured hands-free kit which offers data and fax connection, ignition on/off and radio mute as standard. Talk time is almost five hours with the largest battery, and standby time up to an impressive 200 hours — subject to local network performance.

By the end of the year selected models will also offer a 9600b/s fax and data capability, using an optional data card. Fizz will also offer a Twin Data Card which, in addition to the features of the Mobile Data Card, can be connected to fixed line networks to provide a transmission speed of up to 28,800b/s.

'C-TICK' TO PROTECT AUST. CONSUMERS

Australian households will become a more 'pollution free environment' with the introduction of new standards for electrical and electronic equipment that will cut the electromagnetic interference (EMI) that often causes problems with computers, televisions and other electrical equipment around the home.

EMI is generated by all electrical and electronic products. Most of us have experienced the nuisance of this interference on our television sets, radios and PCs, often caused by use of such appliances as hair dryers, electric drills and blenders. The interference can also have much more sinister effects. One man discovered that the reason his TV reception was so bad was because of interference from the thermostat on his electric blanket. In another similar case it turned out to be the next door neighbour's waterbed thermostat!

Before this electrical 'pollution' becomes a major problem in Australia, the Commonwealth's manager of the radiocommunications spectrum — the Spectrum Management Agency — has developed standards for all products that might cause interference, including household electrical equipment, portable tools, lighting, radios and television receivers. The standards have been designed so that all Australians can get the best quality from all of our appliances, working together, without any interference.

To help consumers identify products that have met the new standards, a 'C-Tick' symbol will be visible on the outside of the product, near the model name. The C-Tick is the customer's guarantee that their product has been manufactured to meet technical standards that reduce electromagnetic interference (EMI) in all electrical and electronic appliances.

From 1 January 1997, the C-Tick will be labelled on all equipment made in Australia or imported. It is in line with international standards for the reduction of EMI and complements the introduction of an Electromagnetic Compatibility (EMC) framework which is being phased in by the Spectrum Management Agency.

The C-Tick means an appliance is designed to operate within the SMA standards for EMI, and in line with the rest of the world. ❖

NEWS BRIEFS

- A conference titled ***Electronic Publishing***, which concerns on-line publishing technology, will be held at Parkroyal, Darling Harbour, Sydney on 14-15 October 1996. Phone (02) 9210 5700 for details.
- ***HarTec*** has been appointed the Australian and New Zealand distributor for Transwitch Corporation, which makes integrated semiconductor products for communication applications.
- Gordon Cheever has been appointed area manager for South East Asia for ***Itron Australia***.
- A two day training course ***EMC — Solving the Problem*** will be held at AEDC, Broadmeadows, Victoria on 28-29 October 1996. For details phone (03) 9302 1422.
- ***HarTec*** has been appointed the Australian and New Zealand distributor for Hyundai Electronics, makers of memory and other semiconductor products.
- Sydney-based ***Oatley Electronics*** has set up a World Wide Web page at **http://www.ozemail.com.au/~oatley**. The company's e-mail address is **oatley@world.net**.
- UK based supplier of data/telecom equipment Astralux Dynamics has announced a move into the New Zealand market, via its Australian electronics distributor ***Adilam Electronics***. Adilam has recently opened offices in both Auckland and Christchurch, and is well poised to address the NZ market. Further information is available from Adilam Electronics in Auckland on (09) 622 4213 or Christchurch on (03) 366 2577. ❖

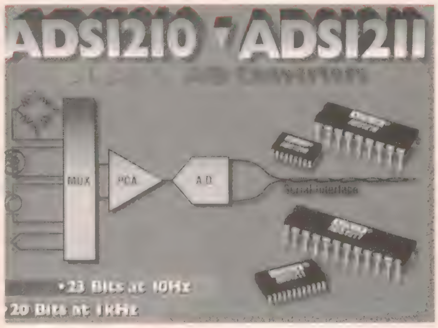
Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

24-bit delta-sigma ADC has 'turbo mode'

The new ADS1210 and ADS1211 from Burr-Brown are precision, wide dynamic range, delta-sigma A/D converters with 24-bit resolution devices that operate from a single +5V supply. The ADS1210 is a single channel converter, while the ADS1211 provides four multiplexed channels. Both converters include a synchronous serial interface which is SPI compatible, and a two-wire control mode for low-cost isolation.

The devices feature a customer programmable 'turbo mode' operation which allows selection of the oversampling ratio of the modulator to match application requirements. With turbo mode, the conversion process oversamples the input signal by a given amount, feeding the output of the oversampling modulator to a filter/decimator to yield a high resolution data output. The higher the oversampling ratio, the higher the resolution.



In turbo mode 1, the modulator oversamples at 20kHz allowing the converter to achieve 21 bits at 10Hz. Turbo mode 16 oversamples at 320kHz to achieve 20 bits at 1kHz. Specifications include 24 bits no missing codes, 23 bits effective resolution at 10Hz and 20 bits at 1kHz, differential inputs, programmable gain amplifier, internal/external reference, and on-chip self calibration. The ADS1210 comes in 18-pin DIP and 18-lead SOIC packages; the ADS1211 comes in 24-pin DIP, 24-lead SOIC, and 28-lead SSOP packages.

For further information circle 279 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

Varactor for VHF and UHF applications

The new SOT-23 packaged ZC930 series of variable capacitance diodes from Zetex feature octave-tuning capability from a voltage range of one to four volts, making devices in the series suitable for mobile radios, pagers and cellular phone applications, as well as voltage controlled crystal oscillator modules.

At a reverse voltage of 1V, seven of the devices in the new series have a capacitance range between 8.7pF and 95pF, to suit most VHF/UHF applications. The ZC932 has a 'hyperabrupt' capacitance-voltage characteristic, providing a minimum capacitance of 17pF at 1V and a maximum of 5.5pF at 4V, making it suitable for battery powered applications.

The Zetex S0T-23 package has a typical stray capacitance of 0.08pF and a total lead inductance of 2.8nH. This allows the devices, when configured as series pairs, to be used in low cost microwave designs extending beyond 2.5GHz. Zetex guarantees a minimum Q for the series that ranges between 80 and 350 (depending on device type), at 50MHz and a reverse bias voltage of 4V.

For further information circle 274 on the reader service coupon or contact GEC Electronics Division, Unit 1, 38 South Street, Rydalmere 2116; phone (02) 638 1888.

Blue diode laser

HMG Photonics has announced the ICD-430, a solid state blue laser. The output is a single mode 10mW beam at 430nm, derived from the doubled output of a chromium doped crystal. Applications for the new laser include data storage, biofluorescence and lithographic applications, as well as general research.

HMG Photonics is a new joint venture between Melles Griot and Hitachi Metals. Melles Griot designs and manufactures photonic products and Hitachi Metals is a manufacturer of special steels and magnetic materials, and is also engaged in developing new electronic and optical devices.

For further information circle 277 on the reader service coupon or contact Ian Butler, Spectra-Physics, 25 Research Drive, Croydon 3136; phone (03) 9761 5200 or freecall 1800 805 696.

12-bit AD converter has 4-channel multiplexer

Burr-Brown's new ADS7824 is a low power, monolithic 12-bit sampling A/D converter with four-channel input multiplexer, sample/hold, reference clock, and a parallel/serial microprocessor interface. The device can be configured in a continuous conversion mode to sequentially digitise all four channels, making it suitable for industrial process control, test and measurement, and analytical instrumentation applications.

The ADC can acquire and convert 12 bits to within +/-0.5 LSB in 25us while consuming only 50mW. Laser trimmed scaling resistors provide a standard industrial +10V input range and channel-to-channel matching of +0.024%. Key specifications include +/-0.5 LSB max INL and DNL, single +5V supply, and 50uW power down mode. It is available in a 28-pin 0.3" plastic DIP or 28-lead SOIC package, and is specified for operation over the -40°C to +85°C industrial temperature range.

For further information circle 273 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700.

Wavelet video compression IC

Analog Devices has released the ADV601 Video Codec, a device that supports from visually lossless to 350:1 realtime compression and decompression of broadcast resolution digital video (CCIR-601). The company claims to be the first to implement wavelet-based video compression in silicon, and is targeting the new device at the PC video capture and editing market.

The company also claims the device enables the lowest system cost ever available for Super VHS-quality desktop video production.

Quadrant International of Malvern PA, Analog Devices' first ADV601 customer, has announced its new VideoWave will provide PCI-based nonlinear video editing for US$499.00. According to Rick Sizemore, President of Total Research in Multimedia of Scottsdale, Arizona, "This chip is a key enabler to the digital video market. Desktop production will be as pervasive as desktop publishing is in today's business world. And in the near future, we'll see consumer electronics resellers bundling camcorders and capture-equipped PCs together."

The ADV601 allows compressed images to be stored on a typical hard disk using typical capture hardware. For example, the device can store 25 minutes of VHS-quality video in 1GB of hard disk space, which is up to five times more video compared to other editable compression techniques.

Symmetry, scalability, precision and error-tolerance are key advantages of wavelet mathematics, which are claimed to benefit a variety of signal processing applications, including video processing and communications. In wavelet compression, the silicon required for encoding is virtually the same as that required for decoding, making the cost of encoding and decoding equal. This contrasts with MPEG2, where encoding requires professionals to operate the hardware, resulting in much higher costs ($25,000 or more).

Another advantage is that wavelets can be adapted to the transmission infrastructure. The bit stream can be edited on-the-fly and scaled for viewing at whatever resolution and frame rate the target system or transmission channel can support. Because the compressed data representing a frame contains information about the entire image, not simply a block of pixels within the image as with images compressed in JPEG or MPEG, lost data does not result in lost blocks within the image. The error-free bit streams can be used to reconstruct the whole image.

For further information circle 271 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

Instrumentation amp

Analog Devices has introduced the AD622, a device described as belonging to a new class of low-cost, high-performance instrumentation amplifiers. It is claimed to be able to replace discrete two and three op-amp 'homebrew' circuits and to improve common-mode rejection, linearity, and temperature stability, while reducing board space and development costs.

For example, the company claims that compared to a two op-amp resistor network configuration, a single AD622 with no external components provides better common-mode performance and lower gain errors over wider temperature ranges. Specifications include a common-mode rejection (G = 10) greater than 86dB and a gain error (G = 1) less than 0.15% (typically 0.05%). It has a noise figure of 12nV/√Hz at 1kHz and takes a current of 0.9mA from a voltage between +2.6V and 18V.

The device can be used as a unity gain difference amplifier with no external components, or a single external resistor will set the gain from two to 1000. Settling time to within 0.1% of a 10V step is 10us with a gain set from 1 to 100, and the typical slew rate is 1.2V/us. Nonlinearity is 10ppm over its entire gain range; gain versus temperature is guaranteed less than 50ppm/°C; voltage offset is typically 60uV and the input bias current is less than 5nA (typically 2nA). It is available in either an 8-pin plastic DIP or 8-lead SOIC and specified for operation from -40°C to +85°C.

For further information circle 275 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755. ❖

NEW PRODUCTS

Power supplies are CE marked

Melcher has recently concluded a program involving type testing and documentation, and is now able to confirm that all relevant products within its power supply range are CE marked. This coincides with the launch of the company's 860-page databook, which provides a comprehensive technical guide to the company's power supplies.

With over 60 series of products, about 500 standard stocking items, and over 20,000 different product types defined in Melcher's manufacturing programme, CE marking has been a significant investment. The company claims that this will make it easier for purchasers of the equipment to do their own type testing and compliance requirements, as the power supply is a key component in any equipment.

For further information circle 246 on the reader service coupon or contact Scientific Devices Australia, 2 Jacks Road, South Oakleigh 3167; phone (03) 9579 3622.

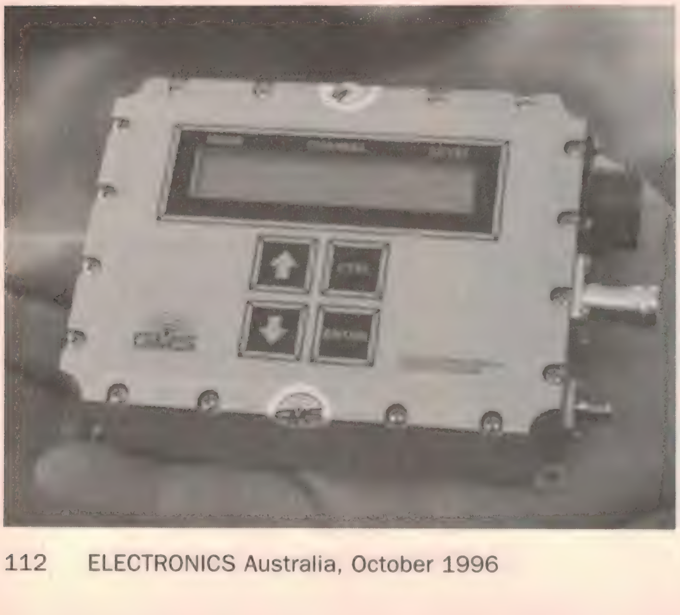
Fuse pattern suits auto pick and place

Philips Components has announced the release of a new addition to the range of Bussmann PCB fuses, called the ETF series. The series is a radial-leaded time lag microfuse rated at 250V AC, in current ratings from 80mA to 6.3A.

Designed initially for use in lighting ballasts and other industrial applications, the 'Type T' pattern has, according to Bussmann, had great success in Europe because it is widely regarded as the most convenient package for automated pick-and-place equipment.

The series carries SEMKO and VDE approvals up to 4A rating and is UL recognised and CSA certified. Fuses are available in both short (4.3mm) and long (18.8mm) leads. The short lead versions are available packed in bulk and both are available on tape. For further information circle 243 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 9805 4479.

Compact microwave ENG transmitter



The STS-3000A is a small, lightweight broadcast ENG S-Band video and audio microwave transmitter capable of operation on up to 60 channels in the 2000 to 2400MHz band. The transmitter can be configured for NTSC or PAL video formats with two balanced audio subcarriers (mic or line). All operating parameters of the transmitter are displayed on a large LCD display and controlled by pushbuttons, which take the operator through a nested menu system.

Audio input levels and the operating channel can be quickly adjusted and the RF power output has three settings from 0.25W to a maximum of 3W. For applications where the transmitter must be located adjacent to the antenna and away from the operator, all transmitter parameters can be remote controlled via a two-wire RS-232 interface.

With the addition of the GMS remote control system (RCB-2000), the operator can control the transmitter remotely, such as where a pilot might need to make changes while in flight to a transmitter located outside the aircraft. The transmitter operates from 11-16V DC and takes 1.5A at full power output.

For further information circle 241 on the reader service coupon or contact Zenology Sales, Suite 7, 1st Floor, 245 Springvale Road, Glen Waverley 3150; phone (03) 9802 0599.

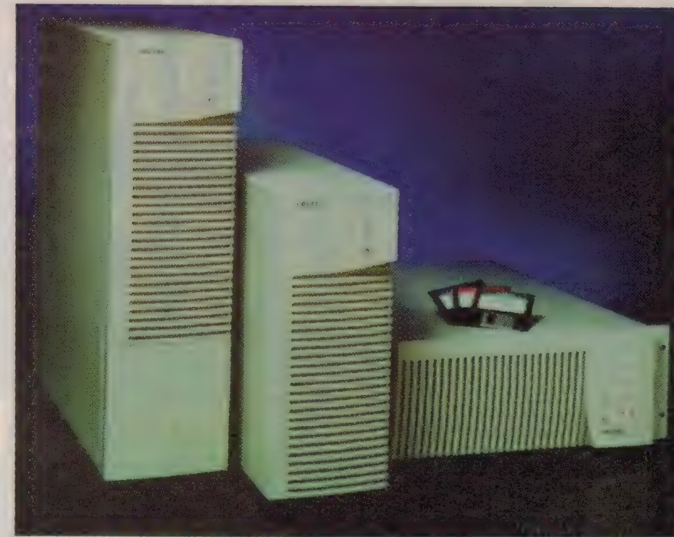
UPS range is small & powerful

The new Deltec PowerWorks series of uninterruptable power systems (UPS) is claimed to give true on-line power protection for sensitive industrial, medical electronic, telecommunications systems, minicomputers and large server-based computer networks. The company also claims that the series has the smallest footprint in its power class, and more protection features for electronic instrumentation and mid-range computer systems than any other UPS in the industry.

The series features dual-conversion technology for low input current distortion and tight power regulation, claimed as a critical feature in maintaining a high power integrity. All models auto-sense 50 and 60Hz and have multiple output voltages for 220, 230 and 240 volts.

Incorporated into the series is Deltec's Advanced Battery Management (ABM) technology, which is claimed to double the life of the UPS battery and to alert users well in advance of battery degradation. ABM technology extends battery life through three charging states: fast, float and rest, eliminating constant trickle charging. ABM also quickly recharges the battery in three to four hours after a blackout.

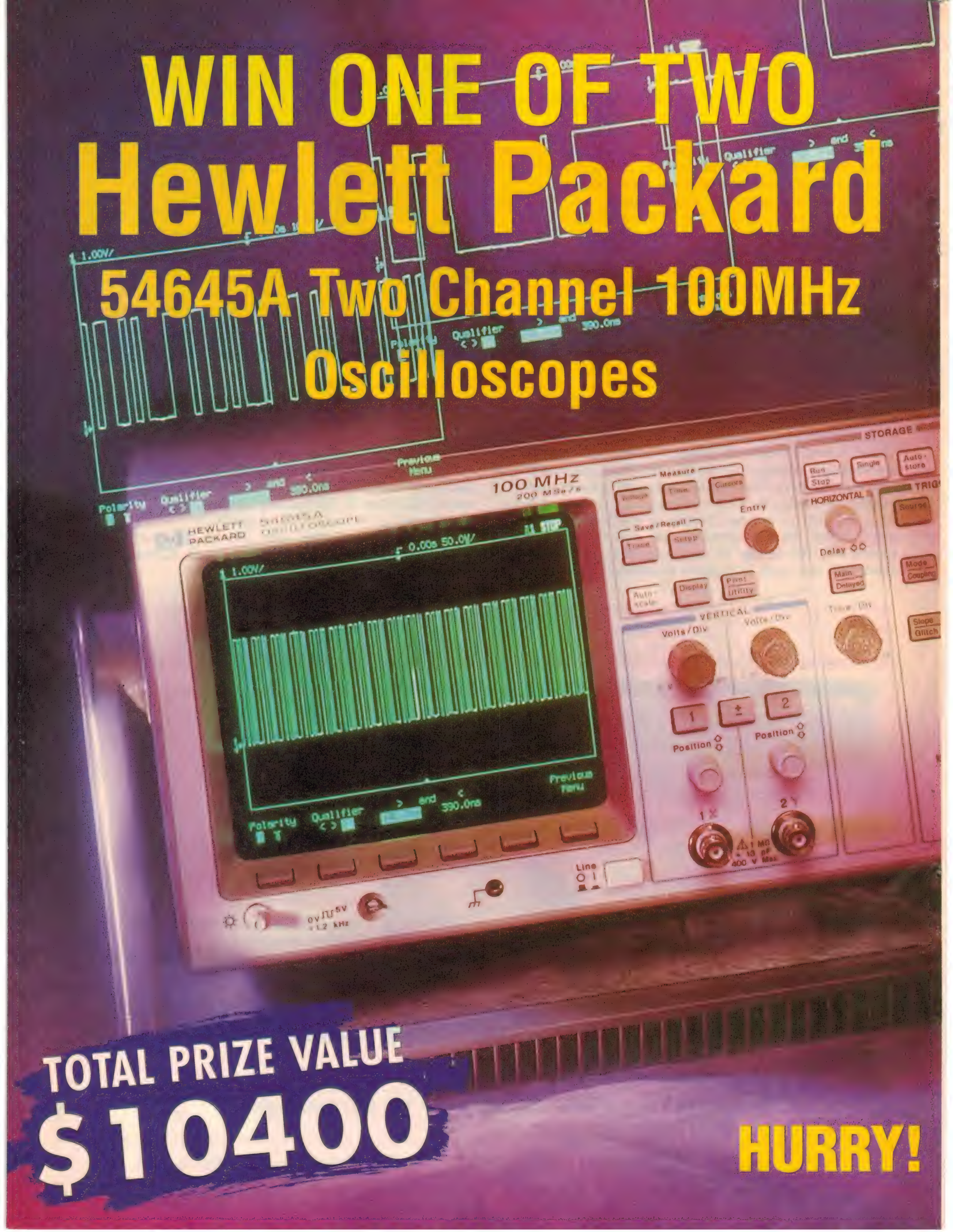
For networked applications, the UPS series interfaces with Deltec's new LanSafe III Power Management software to automatically manage and monitor the exact status of power across the network. Through a management console, users can graphically display the UPS's configuration and power conditions of protected systems. During an unattended power failure, LanSafe III will shutdown all workstations, bridges, routers and file servers in a user-defined sequential order. Open files and work in progress is automatically saved, followed by an orderly shutdown.



The family consists of three models ranging from 3.1kVA to 6kVA in both tower and rack-mount configurations. The 3.1kVA version measures 40cm high x 57.5cm deep x 17cm wide. All units fit in a standard 19" rack.

List pricing for the series begins at $5627. External battery packs for additional battery backup start at $890 and the optional LanSafe III and FailSafe III Power Management software begins at $160 and $142, respectively.

For further information circle 245 on the reader service coupon or contact Online Control, 29-31 Carlotta Street, Artarmon 2064; phone (02) 9436 1313. ❖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The NiMH cell gathers strength

The nickel-metal hydride (NiMH) cell, once hailed as successor to the ubiquitous NiCad, has been facing growing competition from the lithium-ion cell. But, as we explain in this article, recent developments in NiMH battery technology could see this situation reverse.

by PETER PHILLIPS

The search for a 'better battery' has occupied researchers ever since Volta demonstrated his Voltaic Pile in the early part of the 19th century. Since then, different types of batteries have come and gone, rejected because of performance limitations, or for environmental reasons (such as the mercury cell).

An ideal battery should have a small mass and size, and a large energy capacity. And of course it should be rechargeable, as apart from being more economical, there's less environmental damage compared to non-rechargeable batteries that are discarded when exhausted.

Today, the popular types of rechargeable batteries are the lead acid (and all its derivatives), the nickel-cadmium (NiCad), the nickel-metal hydride (NiMH) and the lithium-ion (Li-ion), a relative newcomer. Of these four, the most commonly used technologies in portable equipment (mobile phones, laptop computers) are the NiMH and the NiCad, with the Li-ion becoming increasingly popular.

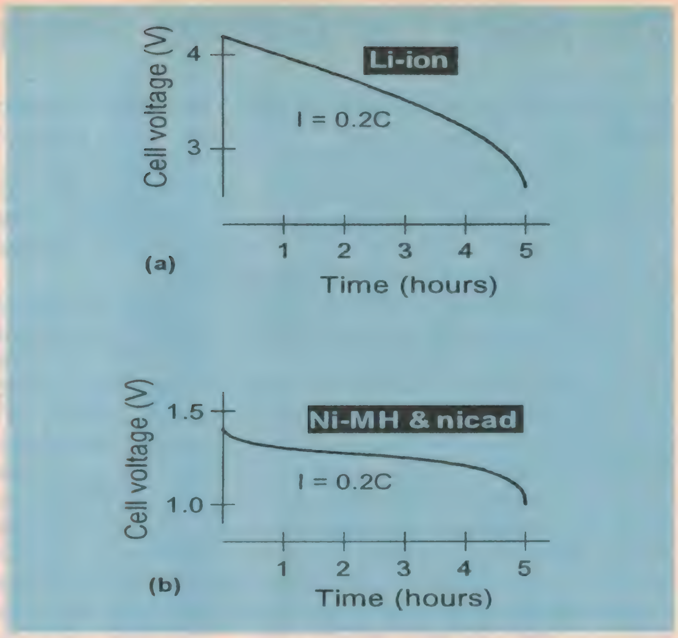
In practical terms, the production volume of Li-ion cells was around 12.3 million cells during 1994, reaching something like 32 million cells in 1995. While a growth figure, it's still a long way short of the 300 million or more NiMH cells produced in 1995. As well, there are limitations still to be overcome with the Li-ion cell. We look briefly at these three cell types in this article, concentrating on the NiMH cell.

The NiMH cell

The NiMH cell was introduced by Sanyo Electric in 1990. Since then it has won widespread use in portable equipment previously powered by NiCads. Its main feature is a higher *energy density*, which is the amount of energy a battery contains in comparison to its volume, typically expressed as watt-hours/litre (Wh/l).

A typical energy density figure for a NiCad is 120Wh/l, compared to about 175Wh/l for the NiMH cell and 230Wh/l

Fig.1: These graphs show the terminal voltage change during discharge of (a) the Li-ion cell with a coke-based anode and (b) the Ni-Cad and NiMH cells.



for the Li-ion cell. In terms of energy versus weight, a NiCad gives about 40Wh/kg, an NiMH cell about 55Wh/kg and an Li-ion cell around 110Wh/kg. The higher energy density of the Li-ion cell makes it an attractive power source for portable equipment, as the battery pack is lighter and smaller compared to other battery technologies.

However, improvements to the NiMH cell have also brought about an increase in its energy density, and this year (1996) Sanyo is releasing a 300Wh/l version. Notice that this figure is higher than that for the Li-ion cell. As well, the company hopes to increase this figure to 340Wh/l by the end of the year.

Another advantage of the NiMH cell compared to the Li-ion cell is cost. As an approximation, the cost per watthour for an Li-ion cell is about double that for an NiMH cell. So given that its energy density is soon to be higher than the Li-ion cell, it's likely we'll see a lot more of the NiMH cell. Here's a short rundown on the characteristics of this cell, compared to the NiCad and Li-ion cells.

NiMH characteristics

There is not a lot of difference between the characteristics of a NiCad and an NiMH cell. They both have the same terminal voltage of 1.2V (nominal) and this voltage remains practically constant during discharge. The nominal terminal voltage of an Li-ion cell is 3.6V but, as shown in Fig.1, drops in an almost linear fashion during discharge.

Note that the graph in Fig.1 is for an Li-ion cell with a coke-based anode, as used by Sony and AT Battery Corp. Cells with a graphite-based anode (Sanyo, Matsushita etc) have a flatter voltage/discharge time curve. However other factors mean the choice of anode material in the Li-ion cell depends on its application, and not just the discharge characteristic.

Because of their relatively constant voltage, a linear voltage regulator can be used with NiCads and NiMH cells; but the Li-ion cell (particularly the coke-based anode type) needs a switching converter for best energy conversion.

The internal resistance of NiCad and NiMH cells is very low (below 0.1Ω for a typical AA cell). The peak discharge current capability of both cell types is therefore very high, and rarely limited by the ESR (equivalent series resistance) of the cell. The Li-ion cell has about 10 times the internal resistance of the NiMH cell, which prevents it being used in equipment that has a high current drain. This includes digital mobile phones (but not analog phones) and power tools.

The self-discharge of NiCad and NiMH cells is much the same, at around 25% per month, compared to 1% per month for the Li-ion cell. NiCads can be fast-charged (15 minutes for a high-rate NiCad), while the fastest charging time for an NiMH cell is typically one hour. An Li-ion cell has a minimum recharge time of around two hours.

NiMH cells seem to be as reliable as NiCads, but (like NiCads) are prone to failure if abused. Typical 'cell killers' are high discharge current and cell polarity reversal, due to excessive discharge. This can happen with any set of series connected cells, in which one cell in the string reaches 0V, then reverses polarity while others in the pack continue to discharge.

NiMH cells are claimed to be superior to Li-ion cells in their charge/discharge cycle characteristics. For example, after 300 cycles, a typical NiMH cell is claimed to retain virtually all its energy capacity, while an Li-ion cell drops to 80%.

As well, the NiMH cell can be stored for long periods with little or no loss of capacity, while the capacity of an Li-ion cell is significantly reduced if the cell is left standing. An Li-ion cell is destroyed if it's discharged too far, and some manufacturers include a sensing circuit inside the battery pack to disconnect the load when the battery voltage drops below a certain point.

Failure modes

A common cause of failure with a NiCad is an internal short circuit caused by crystalline growths, called dendrites, that develop inside the cell when it becomes slightly leaky. Although these can be removed by 'zapping' the cell with a high charge current, or charging the cell with a biased AC current, they regrow unless the cell is continually trickle charged.

According to the manufacturers, leakage and therefore dendrite growth is not a problem with the NiMH cell. As described above,

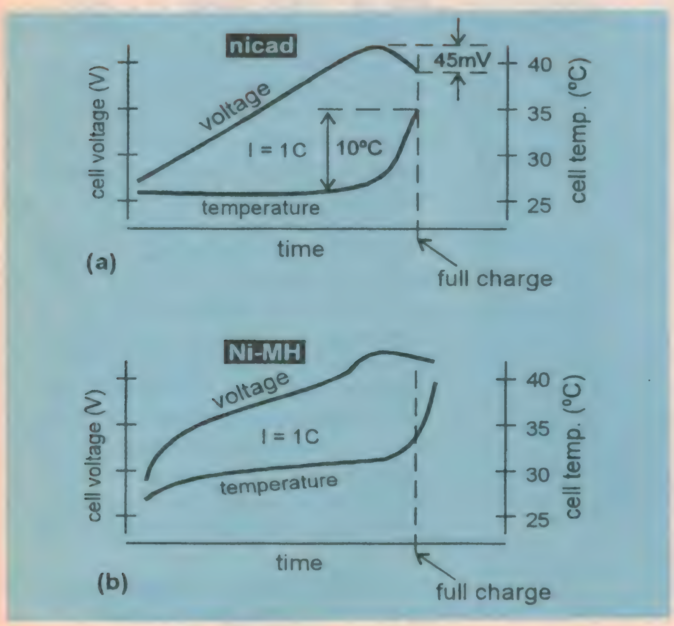


Fig.2: During charging, the internal temperature of both NiCad and NiMH cells rises by 10 degrees when full charge is reached. The terminal voltage of both cells falls at full charge. Sensing either change gives an indication that the cell is charged.

The NiMH Cell Gathers Strength

the Li-ion cell self-destructs if it's discharged below a certain voltage.

A well-known problem with NiCads is the 'memory effect'. This refers to the loss of cell capacity caused by recharging a cell before it's fully discharged. The cell 'remembers' the point at which charging started and, if this process is repeated, will eventually lose capacity. Memory effect is also present in the NiMH cell.

However it's generally agreed that if the shutdown voltage of a battery powered appliance is set to allow a relatively deep discharge (1.05 to 1.1V/cell), the memory effect can be ignored. This applies in particular to mobile phones and portable phones, where it's claimed that even if the battery is used repeatedly after memory effect occurs, the drop in usage time is no more than 10%. And even without a special forced discharge or other refresh function in the charger, the battery can recover to its previous capacity if discharged to the shutdown voltage during normal use.

To minimise failures in NiMH battery packs, protection devices are fitted to prevent damaging the pack due to a fault in the charger, an external short circuit and so on. When volume production of NiMH cells began in 1990, Sanyo recommended using three types of protection devices: a circuit breaker, a thermal fuse and a thermistor, all integrated within the battery pack.

Today, because of improved protection device characteristics, it's common to have only one device fitted to an NiMH battery pack, typically a positive temperature coefficient (PTC) thermistor. This device is fitted in series with the pack, and mounted so it has thermal contact with the pack. A PTC thermistor increases resistance with temperature, so if heated by either an excessive current flowing through it, or a temperature rise in the battery pack, the increased resistance limits the charge and discharge current.

Battery styles

Even though they have only been around for six years or so, NiMH cells and batteries come in a wide range of sizes and package styles. These include the usual AAA, AA, A, C and D cells as well as 10 or 12V battery packs. The Sanyo range includes a 500mAh AAA cell, an 1150mAh AA cell, and others ranging in capacity up to 3.5Ah. The HR-4/3A cell, rated at 3.5Ah, has a diameter of 17mm, a height of 67mm and weighs 56g.

Newer types are a range of button cells, available in similar sizes to comparable NiCad button cells. However, unlike a NiCad button cell which contains around 20% cadmium (of total cell weight), the NiMH version has no cadmium, mercury or lead, making it much more environmentally friendly.

Button cells are specified in DIN 40 765 or IEC 509. Their active components are 'mass electrodes' which are thin pressed tablets enclosed in a conductive nickel gauze. The positive electrode is mainly nickel hydroxide, and the negative electrode is made of metal hydride, a hydrogen storage alloy.

The electrolyte is potassium hydroxide, a solution retained in a fine pore separator, which also acts as an insulator between the electrodes. The assembly is sealed in a steel casing.

Charging techniques

Both NiCad and NiMH cells are usually charged with a constant DC current source. The value of the current is determined by the cell size and type, and the required charge time. The Li-ion cell is charged with a constant voltage source, typically from a charger with a very precise output voltage set to 4.2V with a tolerance of +/-0.05V or better.

Battery charging falls into two categories: fast charge and slow charge. A slow or 'trickle' charge is a continuous charge current that can be applied to the battery indefinitely without damaging the cell. The big advantage of trickle charging is that there's no need for end-of-charge detection circuitry, as the charge current cannot damage the battery, regardless of how long it's sustained. The disadvantage is the length of time to charge the battery.

Most NiCads can tolerate a sustained DC current of 0.1C (1/10 the cell's Ah rating) indefinitely, taking around 12 hours to recharge. For this reason, NiCads dominate cheap consumer products like toys, flashlights and so on. Incidentally, the 'C' rate of a cell is a current numerically equal to the ampere-hour (Ah) rating of the cell.

NiMH cells are not as tolerant as NiCads in this regard. The maximum safe trickle charge current is usually specified

This NiMH battery charger can also be used to recharge NiCads.

by the manufacturer and is somewhere between 0.025C and 0.1C. Exceeding this current can damage the cell, unless some sort of charge termination system is used.

Fast charging

Fast charging for NiCad and NiMH cells is usually defined as a one-hour recharge time, which requires a charge rate of about 1.2C. Some NiCads are designed for very fast charging (15 minutes), and require a charge current of up to 5C. The Li-ion cell is typically fast charged in around two hours, due to the different charge technique.

Both NiCad and NiMH batteries can be fast charged only if they are not overcharged, so an end-of-charge circuit is essential. When either type of cell is overcharged, gas is released through a pressure-activated vent. A NiCad releases oxygen, but an NiMH cell releases hydrogen, which is easily ignited. When gas is released, the cell capacity is reduced.

The usual way to detect the end-of-charge point is to monitor the battery voltage or temperature. As a backup, some charging systems incorporate a timer.

The graphs of Fig.2 show how the voltage and temperature of a NiCad and an NiMH cell change while being charged with a 1C charge current. Notice that the temperature change gives the most accurate indication.

A NiCad cell shows no significant temperature increase until it nears full charge, as its charge reaction is *endothermic*, which means the cell actually cools slightly during charging. When full charge is reached, the energy used in the endothermic charge reaction decreases and the amount dissipated in heat increases, which makes the cell get hot.

Because its charge reaction is *exothermic*, the temperature of an NiMH cell increases during charging. But as full charge is reached, the *rate of temperature rise* increases sharply.

Notice that the temperature rise for both cells is around 10°C, so a charger able to sense and respond to this rise can be used with both NiCad and NiMH cells.

As the graphs show, the terminal voltage of both NiCad and NiMH cells drops when full charge is reached. However, a NiCad exhibits a larger drop than the NiMH cell.

As a result, the voltage change sensing circuitry in an NiMH charger must be at least an order of magnitude more accurate and noise immune than that for a NiCad.

This means a NiMH charger with voltage sensing can be used to charge NiCads, but not the other way around. Fortunately the voltage dips of each cell in a pack of well-matched series connected NiMH cells is additive, which increases the voltage change.

While detecting a voltage dip is a useful way of sensing when a cell is charged, a better way is to sense the *slope* of the change. This requires a microprocessor-based charger able to measure, store and compare battery voltage readings taken at timed intervals.

If successive readings are the same, it means the peak of the curve has been reached. Or the software can test for a voltage decline, as already described.

Battery charger ICs

There are now a number of special purpose charge regulator ICs, such as the TEA1102 and the TEA1104 from Philips. The TEA1102 can be used in chargers for all rechargeable cells, (including Li-ion and lead acid) and is a 20-pin device. This IC has inputs to sense temperature change, voltage change and peak voltage, and can be configured to suit the type of cell being charged.

The TEA1104 is an 8-pin battery monitor IC suitable for NiCad and NiMH cells only. It controls an external current source and has on-board temperature and voltage change sense circuitry.

National has also developed a range of devices for battery chargers, such as the LM2576. This IC is a step-down switching regulator that requires additional end-of-charge sense circuitry.

Summary

As you can see, the NiMH cell has a number of advantages compared to other cell types. Whether it will win out over the Li-ion cell remains to be seen, as the overall size and weight of the battery in portable equipment is seen by many consumers as an important consideration. Less important is cost.

However, if Sanyo achieves the claimed improvements in NiMH cell capacity, then it's likely this cell will be selected by equipment designers over the Li-ion cell, which still has the disadvantage of being more difficult to use.

References

Power Supply Design Information for Battery Powered Products, National Semiconductor Australia.

'Sanyo NiMH Batteries Outperform Li-ion', in *Nikkei Electronics Asia*, May 1996.

'Nickel Metal Hydride Batteries', in *What's New in Electronics*, January 1996.

Philips Data Sheets for the TEA1102 and TEA1104. ❖

Special Feature:

The latest Test & Measuring Instruments

Humidity and temperature indicator

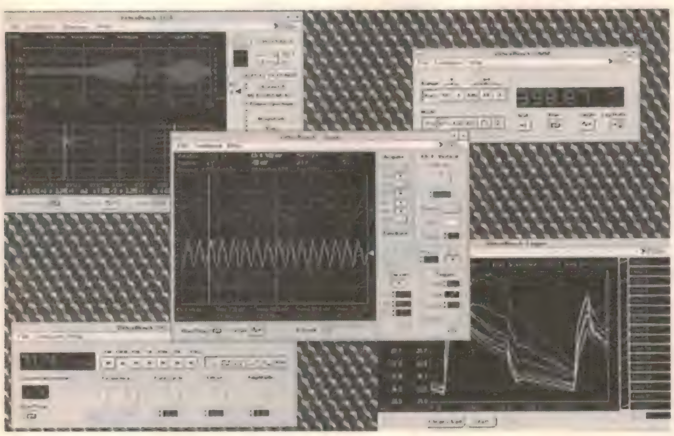
Vaisala has released the HMI41 humidity and temperature indicator. This device is suitable for spot measurements of humidity and temperature in applications such as plant maintenance, inspection of air conditioning systems, production and storage areas.

It is used with the HMP41 and HMP45 probes and is claimed to provide high measurement accuracy, excellent stability and fast response time. The HMP41 probe mounts directly onto the instrument to form a one piece meter for measurements in ambient air. The HMP45 probe connects via a cable, enabling measurements in ducts or chambers. Both probes are fitted with a humidity sensor that is not affected by dew or particulate contamination, and is also immune to most chemicals.

The instrument can calculate dewpoint, wet bulb temperature, absolute humidity and mixing ratio from relative humidity and temperature measurements. It can be supplied with an optional calibration function so the meter can be used as a calibrator for most Vaisala humidity transmitters.

For further information circle 206 on the reader service coupon or contact Vaisala Pty Ltd, 80 Dodds Street, South Melbourne 3205; phone (03) 9696 5699, freecall 1800 335 840.

Family of virtual instruments



National Instruments has announced a family of virtual instruments that combine a data acquisition (DAQ) board, turnkey software and a PC to give the capabilities of stand-alone, traditional instruments. The VirtualBench family has five instruments: an oscilloscope, a dynamic signal analyser, a function generator, a digital multimeter and a data logger, several of which can run simultaneously. When combined with a notebook computer and the company's PCMCIA DAQCards or parallel port DAQPads, the virtual instruments are portable.

As with stand-alone instruments, press buttons and knobs are 'operated' on a VirtualBench front panel to select the measurement function. All instruments save and load custom configuration settings and power up with the settings used when last powered down. The instruments load and save waveform data to disk in a form that can be used in PC software packages, and waveforms and the settings of the instruments can be printed on a printer connected to the PC.

The three or four digit multimeter (depending on DAQ hardware) measures DC and AC voltage and current, resistance and temperature. Input ranges are either autoranged or user selectable from 1mV to 10V. Temperature measurements are made with thermocouples, thermistors or IC sensors. The data logger/strip chart recorder can measure up to 384 channels while simultaneously displaying up to 16 channels, and includes built-in conversion factors for thermocouples and RTDs.

When used with the appropriate plug-in DAQ hardware, the VirtualBench scope has the functionality of a low bandwidth, 4-channel oscilloscope with a sensitivity range from 1mV/div to 10V/div and a timebase range of 10ns/div to 100ms/div. It can record lengths from 500 to 50,000 points and performs 17 types of measurements, including DC, RMS, max and peak to peak voltage measurements.

The dynamic signal analyser is Fast Fourier Transform (FFT) based and performs time, spectrum and network analysis of signals. It measures total harmonic distortion (THD), frequency response, power spectrum, amplitude spectrum, coherence and cross spectrum. The instruments require a Windows 3.x or Windows 95 PC with 12MB RAM and 20MB free hard disk space.

For further information circle 203 on the reader service coupon or contact National Instruments Australia, PO Box 466, Ringwood 3134; phone (03) 9879 5166.

DRAM memory tester

The Chroma 3202 is a portable instrument that can test all types of DRAM and SIMM devices, including single chip DRAM, 30-pin 8 or 9-bit SIMM, or 72-pin 32 or 36-bit SIMM, up to 128M byte capacity. It has a built-in high speed microprocessor, coupled with one gigabyte of address space to test large capacity memory devices.

Using proprietary software, the instrument runs a thorough check of the memory device, testing every memory cell for its access time (from 40 to 120ns), and verifying memory configuration, read/write function, etc. A variety of data patterns and test patterns are stored in the test library.

The test set-up is selected by the front panel function and data keys, and is stored in internal non-volatile memory. The test result is displayed on the front panel LCD, and can be printed out on an external printer. A range of adaptors allows testing of all kinds of memory packaging including SIMM, SIP, PLCC, TSOP, etc. The Centronic port can interface to an auto-handler for automated test management.

For further information circle 201 on the reader service coupon or contact Nucleus Computer Services, 9B Morton Avenue, Carnegie 3163; phone (03) 9569 1388.

Digital scope has long record length.

The new DL1540L digital oscilloscope from Yokogawa is a four channel, 150MHz instrument with a maximum sampling rate of 200MS/s and a record length of 2M words. It weighs 6kg and has a footprint smaller than an A4 sheet of paper.

The scope has an intuitive zoom function which allows any part of a waveform to be enlarged for closer inspection. Its history memory mode permits up to 100 previous screens of data to be recalled. An optional real time printing function enables a low speed signal to be printed continuously on thermosensitive paper while also being observed on the screen.

When operating in 'envelope' mode the instrument will show noise buried in a low speed signal, and for simple noise analysis, it can perform FFT computations. A window trigger function determines whether an unexpected event occurs on the positive or negative side of a steady signal. It generates a power spectrum from data acquired at 1000 points, and has a display update rate of 60 displays per second.

The 'All Scan' function provides accurate time related parameter measurements and the instrument has automatic waveform parameter measurement based on up to 1M word of memory. The scope has a 3.5" DOS-compatible floppy disk drive enabling waveform data to be saved as ASCII or image files. The display image can be used directly in most Windows applications. Front panel settings can also be saved to or loaded from the floppy disk.

For further information circle 202 on the reader service coupon or contact Yokogawa Australia, 25-27 Paul Street North, North Ryde 2113; phone (02) 9805 0699.

Portable data TX test set

The AR-188T handheld transmission test set features several analytical functions including TIMS, impulse, hits, phase jitter, amplitude jitter, return loss and peak to average ratio measurements. The menu-driven operation is selected with a rotary selector switch and pushbutton keypad. Dialling and RS-232 allows automated measurement tasks.

In TIMS mode the tester can transmit and receive signals between 20Hz to 50kHz, and measure signal levels between +10 and -60dBm. It will also detect noise levels from 10 to 100dBm with 1dBm resolution. Transmitter level control is provided via a pushbutton function key. The auto ranging measurements are constantly monitored via a backlit LCD full message display.

A dialling generator (responder, commander) is integrated for activating remote two or four wire responders. This function gives a DTMF, Dialpulse or MF dial signal and when combined with the DC holding circuit, enables communication over the test lines. The test set is supplied with a removable stand, rechargeable battery, AC adaptor, two Bantum to alligator test leads and a soft carrying case for field service applications. An optional printer is used for hard copy of displayed data or configuration data.

For further information circle 204 on the reader service coupon or contact Computronics International, 31 Kensington Street East Perth 6004; phone (09) 221 2121.

The latest Test & Measuring Instruments

Infrared imager

The Thermovision 550 FPA imager from Agema is a hand held infrared measurement and imaging system for inspecting all types of electrical, mechanical and refractory equipment in a preventive maintenance program. It weighs less than 2kg, and can be operated with one hand.

All functions, which are displayed in pull-down menus in the colour viewfinder, are operated with four controls on the back of the camera. A joystick control is used for electronic zoom and focus. Digital voice recording is incorporated in the camera via a headset microphone, so spoken messages can be recorded along with the image data.

Up to 500 images can be stored on each card in a format which enables full analysis of the image at a later date, regardless of the camera settings at the time the images are taken. This means there's no need to spend time making sure the best image is stored while out on a survey.

Features include differential temperature measurement and automatic detection of the hottest spot in an area. An automatic 'best image' function is also included, along with automatic calibration against a built-in temperature reference, a built-in atmospheric transmission model and automatic lens calibration.

Professional quality reports based on data from the infrared imager can be generated with the Windows 95 compatible Agema Infared Systems IRwin 5.0 software package. Reports can be designed to suit, and can include logos (yours and the customer's), and as many infrared images, visual images and tables as required, along with the text.

For further information circle 205 on the reader service coupon or contact Spectra-Physics, 25 Research Drive, Croydon 3136; phone (03 9761 5200, freecall 1800 805 696.

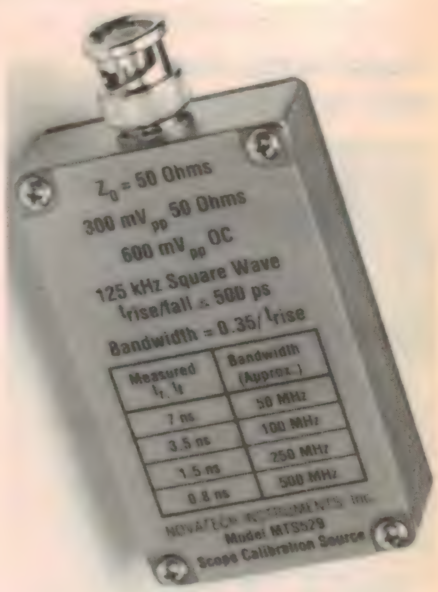
Digital IC tester

The Sunshine Picker 20 is a handheld IC tester for testing TTL 74 series, CMOS 40 and 45 series ICs and a range of DRAM including types 4164, 41256 and 44256. It can be powered from a 9V battery or external plugpack.

The tester has a one line by 16 character liquid crystal display to show IC type and function test. It can also identify a range of digital ICs. Current consumption during operation is 90mA, and in standby is 10mA. The unit also has an auto power-down function, when it takes 5mA.

For further information circle 207 on the reader service coupon or contact Nucleus Computer Services, 9B Morton Avenue, Carnegie 3163; phone (03) 9569 1388.

Handheld scope calibrator



The MTS529 Scope Calibration Source is a battery operated device that connects directly to the BNC input of an oscilloscope. It generates a crystal controlled, 125kHz square wave that has a fast rise time and calibrated amplitude. The period of the generated square wave has a time accuracy of 0.05% and is used to test and calibrate the horizontal timebase.

The square wave rise time is less than 500 picoseconds, which allows the instrument to test oscilloscope bandwidths beyond 500MHz. The amplitude accuracy is within 5% and can be used to verify the vertical amplifier of an oscilloscope. Specifications and photo can be see on the company's WEB site at **http://www.eskimo.com/~ntsales**.

For further information contact Novatech Instruments, 1530 Eastlake Avenue East, Suite 303, Seattle, WA 98102; phone (206) 322 1562.

Fibre optic test tools from Fluke

Obiat has introduced a new fibre optic test accessory that can be plugged directly into a digital multimeter (DMM) for fast, affordable troubleshooting of fibre optic cable systems.

The new Fluke Fibre Optic Meter accessory addresses the growing use of fibre optic cable across a broad band of high-speed voice and data transmission applications and markets, from industrial electrical to telecommunications, data communications (LAN) networks and cable television.

Because the Fluke FOM is designed to work with a digital multimeter, it is especially quick and easy to operate. It provides fast, reliable readings for very demanding fibre optic installations and maintenance, with an accuracy of +/-1dB.

Fluke's complete line of fibre optic accessories allows users a cost-effective way to expand their fibre optic testing capabilities by choosing what is needed for the cable length and type tested, and add new accessories later as needed. Included in the new product line are three fibre optic light sources: the F0S-850, an 850nm light source; FOS-1300, a 1300nm unit and FOS 850/1300, a combined light source.

The Fluke Fibre Optic Meter (FOM) accessory is compatible with all Fluke DMMs or other types that have a mV DC function and 10MΩ input impedance. Used in conjunction with Fluke's Fibre Optic Source (FOS) light sources, the Fluke FOM measures most fibre optic testing needs, from design and installation, to field service and quality control.

For more information circle 208 on the reader service card or contact Obiat at 129 Queen Street (PO Box 37), Beaconsfield 2014; phone (02) 9698 4111 or fax (02) 9699.

Silicon Valley NEWSLETTER

Sony & Philips end DVD alliance, go it alone

In an apparent strategic, yet dramatic move, Sony and Philips Electronics NV have broken up the alliance they formed last fall with a group of eight companies supporting an alternative standard for digital video disks (DVDs). The two giant consumer electronics firms said they were disappointed with the slow pace in developing a common licensing terms agreement.

Besides the threat of a consumer war like the Beta-VHS battle of the 1970s, the Sony/Philips move may cause the electronics industry to miss the opportunity to offer DVD players during the upcoming Christmas shopping season, when the first devices built around the common standard were expected to hit the market.

Some analysts have speculated that the Sony/Philips action is aimed at getting the other eight companies to bring the licensing issue to a speedy conclusion. Last year the Sony/Philips DVD alliance had agreed to work towards a common standard with a consortium of eight companies led by Toshiba. However Jan Oosterveld, a Philips division president, explained that the 10 companies involved had so many differences of opinion that Philips and Sony no longer wanted to wait until that could have been settled.

Instead the two firms said they will now apply the royalty scheme they used for their audio CD standard, in marketing their DVD lines. That means anyone selling DVD players will pay 2.5% of the factory cost of a player to Sony/Philips. To makers of discs, Philips and Sony say they will collect 4.5 cents per disc, slightly more than they get for audio CDs.

IBM, Mercedes link for auto networks

The electronic systems in today's automobiles operate pretty much like isolated islands of machine intelligence. But now Germany's Mercedes-Benz automaker and IBM have agreed to jointly develop networking technology that would link all those systems in order to improve control, diagnostics, and reduce the need to redesign electronic systems with each new model. Financial terms were not disclosed.

The idea of automotive networking apparently came up during a meeting at the Olympics in Atlanta between Helmut Werner, chairman of Mercedes-Benz AG, and Louis Gerstner, chairman and chief executive of IBM.

Initially, IBM and Mercedes said they will develop a new architecture, based on network computing, that will monitor and control many engine, climate, entertainment, lights and other functions. A powerful central automotive server could also be programmed to enable onboard navigation systems to gather and use information outside the vehicle to help drivers react quickly to changing weather and road conditions.

Mercedes-Benz said such systems will reduce the need to develop a new elec-

Ultratech Stepper, Inc. of San Jose has developed its IMAGE (Interactive Maintenance Guide) — an interactive multimedia software program — to provide comprehensive yet friendly guidance for technicians maintaining its lithography stepper machines, used for fabrication of the latest IC chips. Maintenance of such machines isn't easy, as they're fixed inside a high-grade clean room.

tronic system for each new automotive model. Instead, components can be reused from model to model. This reduces costs and speeds the design and manufacturing process.

NEC to make Diba chips — Intel next?

The movement towards 'information appliances' — household devices that deliver computer services without the availability of personal computers — continues to build momentum, as Silicon Valley start-up Diba confirmed it has completed a deal for its software to be used in computer chips manufactured by NEC. Diba is reportedly also negotiating a deal to license its software to Intel.

The NEC chips will be the foundation for products developed by the Japanese company's consumer electronics divisions, but are also designed for sale to other electronics device manufacturers.

Instead of being directed to PCs, the Diba software adds Internet functions and other kinds of interactive features to products ranging from telephones to television sets and entirely new devices, such as pushbutton pads that link people with medical facilities.

"What Windows is to the PC industry, we believe Diba will be to the information appliance industry", says Joe Gillach, the firm's COO. NEC said it had not decided what 'appliances' to produce, but Gillach said they would be of NEC's conception and design.

Diba has announced one deal: Zenith is planning TV sets that can be used for Internet access and e-mail. But Gillach said other collaborations would be announced within six to eight weeks, involving Japanese and Korean firms.

Fujitsu granted US flat panel patent

Flat TV screens that hang on walls like a picture are still a few years away from mass production and consumption. But with rapidly improving efficiencies in flat panel display (FPD) manufacturing technology the market could become one of the largest consumer electronics areas over the next 10 years. When that happens, Japan's Fujitsu will reap in tens of millions of dollars in royalties following the awarding of a valuable patent for its FPD technology by the US Patent & Trade Mark Office.

The patent applies to Fujitsu's 'plasma display panel' (PDP) technology. Unlike conventional CRT and LCD displays, the PDP technology enables the design and production of larger flat screens without a disproportional increase in weight or thickness. The patent Fujitsu obtained controls the display of precise colour pictures on the panel.

Another patent, covering PDP production technology, is expected to be granted in the US as well by the end of this year, according to a company spokeswoman. "The technology is vital and no one can commercialize PDP panels without them", she said.

Already NEC, Pioneer Electronics, Mitsubishi Electric and South Korea's Daewoo have announced plans to produce Fujitsu-type PDPs. Fujitsu said it soon expects to enter into licensing discussions with these and other FPD manufacturers. The company is applying for similar patents in Japan.

Intel moves into Internet phone market

Santa Clara-based Intel, the world's leading chipmaker, is becoming a telephone service supplier as well. The company has announced that it will be distributing free software over the Internet, to enable computer users to gain access to a global network for long-distance telephone calling.

Intel Internet Phone allows PC users anywhere in the world to communicate verbally without having to pay long-distance phone fees. The technology requires computers on both ends of the Internet connection, fitted with a microphone and speakers.

Until now, the Internet telephone market has belonged to a potpourri of small businesses. The Intel action will almost certainly legitimise the cottage industry and prove a bonanza for most players in the market.

TI loses patent infringement case

Texas Instruments officials said they were "baffled" by a US patent court decision to reverse a US$51.8 million damages award TI had won in April against three Silicon Valley chipmakers — Cypress Semiconductor, VLSI Technology and LSI Logic.

The award stemmed from a patent infringement lawsuit TI had filed against the three companies, for having allegedly illegally copied TI technology related to sealing chips in a plastic package.

The reversal was all the more surprising to TI because in two previous cases the same patent had been upheld. The court's decision follows an August 1995 court ruling by US District Judge Barefoot Sanders in Dallas, who said that a jury verdict was correct in finding the patents valid, but incorrect in finding infringement by the defendants. ❖

IBM to build 'nuclear supercomputer'

IBM has received a US$93 million contract to build a three-teraflop massively parallel processing-based supercomputer for the US Department of Energy. The machine will be capable of simulating nuclear explosions, eliminating some the need for actual tests — which are now severely restricted.

The Option Blue system will be built around a powerful version of the same PowerPC microprocessors used in the Apple Macintosh family of computers. The system's architecture consists of multiple nodes, each containing eight CPUs.

In the first phase, IBM will install 64 nodes at the Lawrence Livermore Laboratory just outside Silicon Valley. That will be enough for engineers and programmers to develop and test the application software for the project. Then in June 1997, IBM will replace the processors with new, faster versions and start adding more nodes. By 1998, the full computer systems will consist of 512 nodes (4096 processors).

When fully operational, Option Blue will compute at up to 3×10^{12} floating-point calculations per second (three teraflops), 300 times as fast as the most powerful computers today. It will come equipped with 2500 gigabytes of main memory.

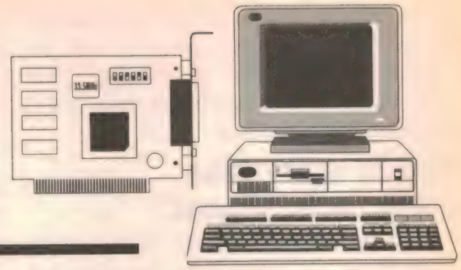
According to David Cooper, associate director for computation at Livermore, a machine that would render all physical atomic tests permanently unnecessary would have to perform at the rate of at least "one petaflop — about 300 times faster than Option Blue — and possibly at an exaflop, or 300,000 times as fast as Option Blue". Cooper said he is confident that such a machine will be built around the year 2015.

Option Blue will effectively explode nuclear devices in cyberspace, simulating their devastating effect in the form of mathematical equations developed with data from the 1000 or so physical nuclear bomb tests the United States has performed since 1945.

Unlike many other defence-oriented computers, the DoE said it will make time available on the supercomputer for other research organizations, and even private industry to perform complex simulation experiments.

"It will have civilian uses, like auto crash simulation and safety design", said Hazel O'Leary, US Energy Secretary. "It can be used for designer drugs, to speed up understanding how they react to cure diseases. It can be used in airplane design, to reduce energy consumption, or in weather predictions and global warming simulations."

Computer News and New Products



Sealed box data storage system

An Australian invention for secure data storage has been released by JED Microprocessors, for use with data logging systems or industrial control and data acquisition systems. Called the Datasafe, the device is claimed to be much more robust than PCMCIA, floppy or removable hard disks as no drives or adaptors are needed at either end of the transfer. Instead it uses the RS-232 port of the systems.

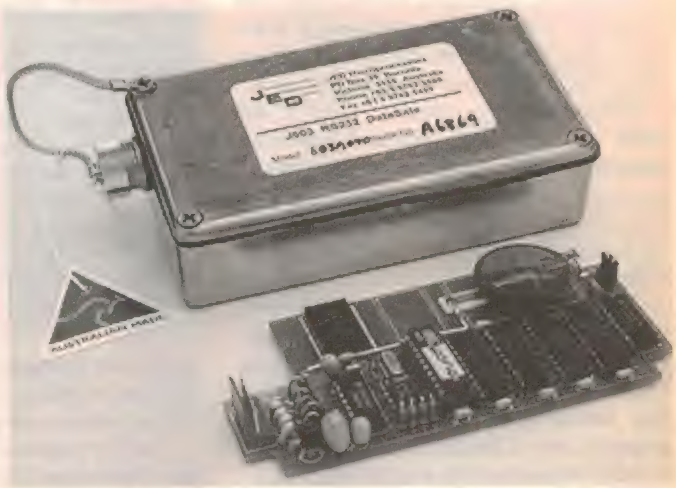
The DataSafe housing is a diecast metal box (114 x 64 x 31mm), sealed to IP66, and also sealed for RF emissions. A protective cap is supplied to seal it for transport. Mating connectors are made by several suppliers (R04 style 6-pin connector), and can be supplied with PC-compatible cables or left for users to terminate. The box is powered by the RS-232 control and data lines, so no extra power is needed.

The unit contains from 512KB to 4MB of CMOS battery-backed RAM accessible via the RS-232 interface, at speeds from 2400 to 38,400kb/s. A CMOS microprocessor inside the box receives data transfer commands and loads or replays data from anywhere in the memory, under control of the host system. Using simple commands, each block transfer can be from one to 256 bytes in length from anywhere in the address space.

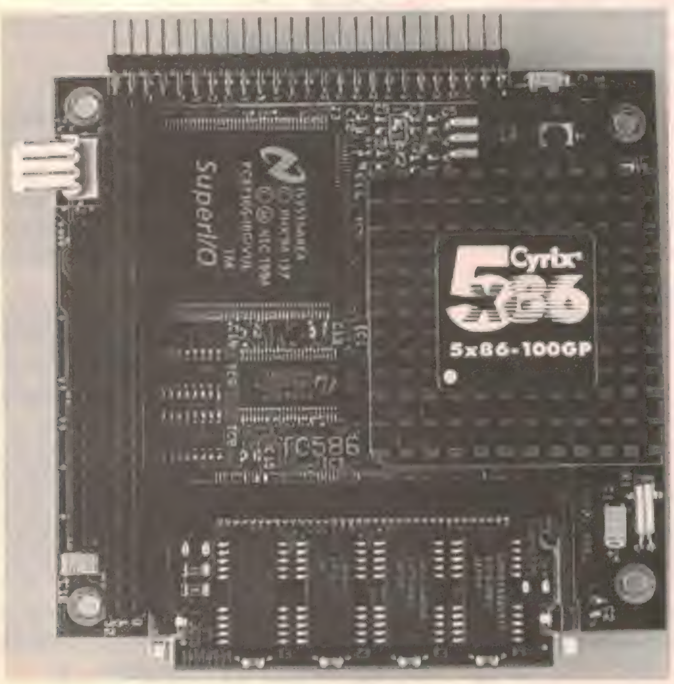
It wakes up in 'locked' mode, so before any write operation, the unit must be 'unlocked' with a specific command. An EEPROM in the device controls the data rate, memory limits, serial numbers, location codes, etc.

The software can be customised by JED to interact with user-defined protocols for up- and downloading, either triggered by an RS-232 command, or triggered by raising an RS-232 control line. Software for the data transfer is available in C source and *.EXE form, and can be grafted onto user-written programs to reformat the data to make it compatible with spreadsheet or data analysis programs.

For further information circle 161 on the reader service coupon or contact JED Microprocessors, Office 7, 5-7 Chandler Road, Boronia 3155; phone (03) 9762 3588.



Pentium performance on a PC/104 card



A new PC/104 processor card from DSP Design, the TC586, is claimed to be the first true 'Pentium class' performance PC/104 processor. The card has a choice of power and performance with throughput at either 100MHz or 120MHz, both requiring only a 5V power supply. A 3.3V voltage regulator is built in as standard. Alternatively, '486 DX2 or DX4 processors can be fitted to suit application requirements.

The card is also claimed to have the smallest footprint (90 x 96mm) of any Pentium class PC. On-board resources include two RS-232 serial ports, one of which can be converted to RS-485, a parallel port configured as Centronics, mouse, keyboard and speaker ports. Included also are standard PC interrupt and DMA controllers and timers.

The card includes 1MB of Flash memory containing the BIOS (or optionally the application code), which can be increased to 32MB (max) with an additional plug-in card and a standard DIMM socket (with a choice of DRAM size of 4MB, 8MB or 16MB). The Flash file system enables users to download or upgrade on-board software. The card can be used either within a PC/104 stack or as a stand-alone single board processor. It is pin compatible with other PC/104 processor modules, allowing it be used as an upgrade in existing systems.

For further information circle 160 on the reader service coupon or contact DGE Systems, 103 Broadmeadow Road, Broadmeadow 2292; phone (049) 613 311.

Neumann catalog on a CD-ROM

Available for both Macintosh and Windows computer environments, the interactive Neumann microphone CD-ROM catalog contains information on the Neumann range of microphones and accessories.

The CD-ROM features audio visual slide shows with photographs of all Neumann microphones and applicable accessories, together with comprehensive specifications, frequency response curves, polar patterns and filters, as well as application notes for each microphone.

It also contains an interactive photo album featuring highlights from 68 years of Neumann history, an integrated encyclopaedia of technical terms and specifications, and a worldwide listing of all Neumann sales and service outlets. It features context sensitive help with operating hints, direct access to all information with alphabetic search, and a print function to output any page to a printer.

For further information circle 164 on the reader service coupon or contact Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 9975 1211.

Industrial workstations

Intelligent Systems Australia has announced the release of the new IAC-W900 series of industrial workstations. These workstations include a 10.4" TFT or STN LCD colour monitor and have been specifically designed for the factory floor and harsh industrial environments. A filtered, high-flow ventilating system keeps the system cool and a dustproof door protects the keyboard connector and disk drives from contaminants.

The IAC-W900 meets the EIA RS-310C rackmount standard, supports ISA and PCI bus 8/12/14-slot passive backplanes, and can be configured with various full-size and half-size CPU cards. It also supports the popular inexpensive baby-AT motherboard and includes a 54-key sealed membrane keypad, standard DIN connectors on the front and rear panels and space for three 3.5" and one 5.25" disk drives.

The series can accept the popular low-cost PS/2 type power supply but will also support the IAC hot-swap redundant power supply. It has an operating temperature of -10°C to 55°C and includes four 90mm cooling fans. Touchscreen is also available as an option.

For further information circle 165 on the reader service coupon or contact Intelligent Systems Australia, PO Box 118, Berwick 3806; phone (03) 9796 2290. (Web site at **http://www.intelsys.com.au**)

Newsletter for SPICE users

The Intusoft Newsletter is a free publication dedicated to the SPICE circuit simulation program. The latest issue contains several application notes. The first discusses a new methodology for producing Berkeley SPICE models of transformers or inductors. A general topology for a SPICE subcircuit of a magnetic device is detailed, along with information on how the values for different elements can be calculated. Several example transformer models are included.

The second article discusses the new BSIM3 version 3 MOSFET model (the latest deep-submicron MOSFET model from the University of California at Berkeley) that has been implemented in the IsSpice4 analog simulation program. It is a physical model based on a coherent quasi two-dimensional analysis of the MOSFET device structure, taking into account the effects of device geometry and process parameters. The article includes sample simulations showing the DC, AC, and transient performance of the model.

The last application note discusses how SPICE can be used to simulate mechatronics problems. These are designs in which mechanical, electrical, and other system oriented (mathematical) elements must interact with one another. SPICE modeling examples for a synchro and a resolver are provided. A floppy disk containing all of the schematics and SPICE models in the newsletter along with new Analog Devices IC models, new Teccor SCR models, new Powerex IGBT models and new digital IC models is available for a nominal fee. An electronic version (Adobe Acrobat document) of the Intusoft Newsletter is posted on Intusoft's Web site (**http://www.intusoft.com**) and on CompuServe (CADD/CAM/CAE vendor forum).

For more information contact ME Technologies, PO Box 50, Dyers Crossing 2429; phone (065) 50 2200 or fax (065) 50 2341.

Modem for high security applications

Banksia Technology has released the Citadel, a 24-bit professional modem designed for organisations wanting absolute security in data communications. The modem incorporates a separate hardware processor dedicated to encryption, and delivers fully encrypted data at up to 28.8kb/s (or up to 230.4kb/s with data compression).

Features include tamper-resistant security, ultra fast transmission of encrypted files and leased line support. It also includes second line dial-back security so callers attempting to access network information can be called back on a second line, preventing unauthorised persons 'camping' on the line in an attempt to break into the network.

Implementing DES, the worldwide encryption standard, the modem incorporates 56-bit Chained Cipher DES, authentication prior to encryption, and unique session key generation for each call. Because no key is ever transmitted across the link, there is no possibility of unauthorised users accessing the key and decoding vital information.

The separate encryption processor also relieves the standard processor from its normal data compression and error correction functions, allowing additional processing power for multi-level security. The modem is claimed to be the first in Australia to use the 24-bit Motorola 68356 integrated processor, the latest in DSP (digital signal processor) technology. The RRP of the modem is $1099. It can be upgraded to the new speed of 33.6kb/s.

For further information circle 166 on the reader service coupon or contact Banksia Technology, Banksia House, 25 Sirius Road, Lane Cove 2066; phone (02) 9418 6033, BBS (02) 9418 7693.

World modem on a PCMCIA card

TDK's new DF2814 PC card is a high speed (V.34) PCMCIA data/fax modem designed for data/fax transfer via phone systems. It's aimed at the small office home office (SOHO) market and is suited to field applications requiring communication back to the office. For use with notebook, laptop or portable fax machines, the card is available for both IBM (compatible) and Apple systems.

According to TDK, the card is the world's first international modem which can be used legally and reliably in more than 20 countries around the world. It comes with country selector software, so the modem is automatically configured for use in that country, with the electronics in the card set to adapt to the electrical characteristics of that country's phone system.

The card includes a high speed parallel port as well as a conventional 16550 type serial port. The parallel port driver is claimed to process characters much faster than the standard Windows driver. The card supports Microsoft, DOS, Apple and Windows 95 applications.

For further information circle 163 on the reader service coupon or contact TDK, 22 Lambs Road, Artarmon 2064; phone (02) 9437 5100. ❖

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LM3909N	LED Flasher/Oscil	2.85
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MC14411P	Baud Rate Generator	27.45
MM5369AA/N	3.58MHz/60Hz Divider	3.90
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TL170CN	Hall Effect Switch	1.60
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XR-2206CP	Function Generator	10.00
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Telecom Function

14409	Binary to Phone Pulse	11.55
AM7911PC	World Modem	62.85
LM565CN	Phase Locked Loop	4.60
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MC68681	See XR-68C681CP	27.25
MC145436AP	DTMF Decoder	4.75
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2N2222		1.00
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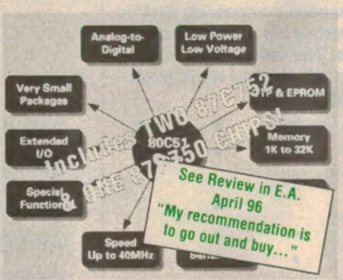
2N3053	NPN 40V 150mA Amp	1.15
2N3069		1.00
2N3440	NPN TO39 250V 1A	1.45
2N3719		1.30
2N3740	PNP TO66 60V 4A	9.70
2N3771	NPN TO3 40V 30A	6.45
2N3772	NPN TO3 60V 20A	6.25
2N3822	NFET TO72 50V 10mA	2.55
2N3829	PNP TO92 30V	3.75
2N3860	NPN TO92 30V 2mA	0.35
2N3904	NPN TO92 60V 100mA	0.25
2N3905	PNP TO92 40V 100mA	0.25
2N3906	PNP TO92 40V 100mA	0.25
2N3956	NFET Dual TO72 20V 200u	6.15

Here's the low cost way to get into Microcontrollers with the DS-750 Development Kit from Philips for only $159.90!!



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2N4288	PNP TO92 30V 10mA	3.05
2N4360	PFET TO92	1.55
2N4401	NPN TO92 60V 500mA	0.30
2N4403	PNP TO92 40V 500mA	0.15
2N4443	SCR TO218 400V 8A	7.75
2N5086	PNP TO92 50V 10mA	0.35
2N5087	PNP TO92 50V 10mA	0.35
2N5401	PNP TO92 150V 600mA	0.25
2N5461	PFET TO92 TO71 10V 700u	0.90
2N5485	NFET TO92 25V 10mA	0.70
2N5550		0.25
2N5551	NPN TO92 180V 10mA	0.20
2N5656	NPN TO126 300V 500mA	5.85
2N5871		3.75
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2N5945	NPN 28V 7W 175MHz	5.50
2N5946	NPN 12.5V 10W 512MHz	5.50
2N5953	NFET TO92 30V 5mA	1.75
2N6073	Triac TO216 400V 4A	1.25
2N6121	NPN TO126 45V 4A	3.05
2N6136		5.50
2N6155		3.60
2N6397	SCR TO220 400V 12A	5.10
2N6401		2.55
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BC107	NPN TO18 40V 100mA	0.60
BC108	NPN TO18 20V 100mA	0.65
BC177	PNP TO18 45V 100mA	0.80
BC178	PNP TO18 25V 100mA	1.55
BC308-92	PNP TO92 30V	0.45
BC309-92	PNP TO92 25V	0.45
BC318	NPN TO92 30V	0.40
BC327	PNP TO92 45V 500mA	0.20
BC328	PNP TO92 25V 500mA	0.20
BC338	NPN TO92 45V 500mA	0.15
BC337	NPN TO92 45V 500mA	0.20
BC516	PNP TO92 D/TON 30V	0.40
BC546	NPN TO92 60V 100mA	0.15
BC547	NPN TO92 45V 100mA	0.15
BC548	NPN TO92 30V 100mA	0.15
BC549	NPN TO92 30V 100mA	0.15
BC556	PNP TO92 65V 100mA	0.15
BC557	PNP TO92 45V 100mA	0.10
BC558	PNP TO92 30V 100mA	0.15
BC559	PNP TO92 30V 100mA	0.15
BC639	NPN TO92 80V 1A	0.40
BC640	PNP TO92 80V 1A	0.40
BD139	NPN TO126 80V 1A	0.60
BD140	PNP TO126 80V 1A	0.60
BD236	PNP TO126 60V 2A	0.90
BD437	NPN TO126 45V 4A	1.00
BD439	NPN Power TO126	1.50
BD440	PNP Power TO126	1.50
BD646	PNP TO220 D/ton 60V 8A	0.95
BD677	NPN TO126 60V 4A	0.90
BD681		1.10
BD682	PNP TO126 D/ton 100V	0.95
BD948	PNP TO220 45V 5A	1.35
BF199	NPN RF Amp	0.30
BF336		1.30
BF419	NPN TO126 250V 100mA	1.35
BF470	NPN TO126 300V 50mA	2.00
BF494	NPN TO92 30V 30mA	0.95
BF495	NPN TO92 30V 30mA	0.45
BF960	MFET SOT103 20V 20mA	1.25
BFQ24	PNP TO72 12V 35mA	6.80
BFQ53	NPN TO72 14ma 10V	3.60
BFR91	NPN SOT37 12V 35mA	2.00
BFR96S	NPN SOT37 860MHz	1.55

BFY50	NPN TO39 35V 1A	2.00
BFY51	NPN TO39 30V 1A	2.10
BFY90	NPN TO72 15V 25mA	3.05
BRY-39		1.30
BS170	NMFET TO92 60V 500mA	0.70
BS250	PMFET TO92 45V 250mA	1.15
BSN254A/126	NMFET TO92 250V	0.75
BST100	PMFET TO92 50V 250mA	1.90
BSV80	NFET TO18 40V 10mA	2.10
BSX59	NPN TO39 45V 1A	1.90
BT136-500	Triac TO220 500V 4A	1.40
BT137-500	Triac TO220 500V 8A	3.35
BT138-500	Triac TO220 500V 12A	4.15
BT139-500	Triac TO220 500V 16A	5.45
BT139-800	Triac TO220 800V 16A	4.00
BTY91-800T	800V 25A Thyristor	39.25
BU406	NPN TO220 400V 7A	2.95
BU508A	NPN SOT93A 700V 8A	4.75
BUK436-60A	PMFET SOT199 60V 50A	11.15
BUK456-100A	NMFET 100V 34A Rds.05	7.15
BUX84	NPN SOT82 400V 2A	2.35
BUZ11A	MFET TO220 50V 38A	3.75
BUZ08A	NPN TO3 400V	7.80
BUZ10	MFET TO220 50V 12A	5.15
C106D	SCR TO126 400V 4A	1.00
C122DI	SCR TO220 400V 8A	4.05
IRF630		5.70
IT1750	N Channel MOSFET	10.45
LM394CN	Supermatch Transist	7.70
LM3086N	Transistor Array	1.15
LM3146N	Transistor Array	2.75
LP395Z	Low Power LM395	1.25
MJ802	NPN TO3 100V 30A	8.45
MJ3001	NPN TO3 80V 10A	8.00
MJ4502	PNP TO3 100V 30A	9.40
MJ11015	NPN TO3 400V 50A	13.20
MJ15003	NPN TO3 140V 20A	6.85
MJ15004	PNP TO3 140 20A	6.55
MJE1100	NPN TO-126 60V 5A	12.60
MJE2955	PNP TO127 60V 10A	5.05
MJE3055	NPN TO127 60V 10A	5.70
MJE340	NPN TO126 300V 500mA	2.70
MJE350	PNP TO126 300V 500mA	1.35
MJE800	NPN TO126 D/ton 60V 4A	2.35
MJE13007	NPN TO220 400V 8A	4.25
MPSU10	NPN TO202 300V 500mA	2.10
PN100	NPN GPA	0.15
PN200	PNP GPA	0.15
PN3563	NPN/UHF	0.40
PN4122	PNP TO92 40V 50mA	0.40
PN4250	PNP/LL	0.30
PN4355		0.40
TIC206A	TRIAC TO220 100V 4A	4.75
TIP29C	NPN TO220 100V 1A	1.20
TIP30C	PNP TO220 100V 1A	1.20
TIP31C	NPN TO220 100V 3A	1.10
TIP33C	NPN TO220 100V 10A	2.00
TIP34C	PNP TO218 100V 10A	1.90
TIP35C	NPN TO218 100V 10A	4.05
TIP36C	PNP TO218 100V 25A	4.20
TIP41C	NPN TO220 100V 6A	1.35
TIP42C	PNP TO220 100V 6A	1.40
TIP110	NPN TO220 60V 2A	0.95
TIP122	NPN TO220 100V 5A	1.75
TIP3055	NPN TO218 100V 15A	2.55
TSB3055	NPN TO219 60V 15A	2.90
ULN2001CP		2.15
ULN2002CP		2.15
ULN2003A	DS2003CN	1.45
ULN2004A		1.70
ULN2068	Quad 50V 1.5A Driver	5.35
ULN2801		2.80
ULN2803A	Octal CMOS Driver	2.80
ULN2804A		2.05

Voltage References

ICL8069	1.2V Reference	6.85
ICL8211CPA	Pgmbl Reference	5.65
ICL8212CPA	Pgmbl Reference	5.65
LM329DZ	6.9V Reference	1.35
LM334Z	Constant Current SRC	2.40
LM336Z-2.5	2.5V Reference	2.35
LM336Z-5.0	5.0V Reference	2.30
LM385Z	Adjustable Reference	3.30
LM385Z-1.2	1.2V Reference	2.85
LM385Z-2.5	2.5V Reference	2.65
LM399H	Temp Comp Reference	6.45

Voltage Regulators

ICL7663ACPA	CMOS Regulator	9.80
ICL7665ACPA	Under/Over Detector	8.75
L200C	2A Adjtbl Regulator	3.15
LM309H	3 Term 5V Regulator	6.10
LM309K	5.0 Volt Regulator	4.15
LM317HVH	3 Term Adjust Pos Reg	11.85
LM317HVK-STEEL	3 Term Adjust Pos	11.75
LM317K	3 Term Adjust Pos Reg	5.85
LM317LZ	3 Term Adjust Pos Reg	1.00
LM317T	3 Term Adjust Pos Reg	1.65
LM320H-5.0	3 Term Fixed Rgltr	10.50
LM320MP-12	3 Term Fixed Rgltr	5.45
LM320MP-15	3 Term Fixed Rgltr	3.20
LM320T-12	See LM7812CT	4.75
LM323K-STEEL	3A/5V Regulator	11.80
LM325N	Dual Tracking Reg 15	15.75
LM330T-5.0	Lo I/O Diff Rgltr	2.10
LM337H	3 Term Neg Regulator	9.30
LM337HVH	3 Term Neg Regulator	15.20
LM337HVK-STEEL	3 Term Neg Reg.	19.10
LM337K-STEEL	3 Term Neg Reg.	10.65
LM337LZ	3 Term Neg Regulator	1.70
LM337MP	3 Term Neg Regulator	2.70
LM337T	3 Term Neg Regulator	2.00
LM338K-STEEL	5A Adjust Pos Rgltr	11.65
LM7805KC	See LM309K	4.35
LM7812KC	Fixed Pos Regulator	2.75
LM7824KC	Fixed Pos Regulator	5.45
LM7805CT	Fixed Pos Regulator	1.50
LM7812CT	Fixed Pos Regulator	1.70
LM7815CT	Order as MC7815CT	1.55
LM7824CT	Order as MC7824	1.95
LM341P-5.0	Fixed Pos Regulator	1.55
LM341P-12	Fixed Pos Regulator	1.55
LM341P-15	Fixed Pos Regulator	1.55
LM342P-5.0	Fixed Pos Regulator	2.00
LM342P-12	Fixed Pos Regulator	2.00
LM342P-15	Fixed Pos Regulator	1.20
LM350K-STEEL	3A Adjust Pos Rgltr	11.40
LM350T	3A Adjust Pos Rgltr	4.45
LM376N	Positive Regulator	1.10
LM723CN	Positive Regulator	1.05
LM2925T	LDO Regulator Del Reset	2.55
LM2575T-5.0	Step Down Switch Reg	7.50
LM2575HVT-12	60V Vers LM2575T-12	10.60
LM2576T-ADJ	Step Down Switch 3A	9.55
LM2575T-ADJ	Step Down Switch Reg	8.00
LM2577T-ADJ	Step Up Switch Reg	9.55
LM2930T-8.0	Lo I/O Diff Rgltr	2.15
LM2931AZ-5.0	Lo I/O Diff Regulator	1.75
LM2931CT	Lo I/O Diff Rgltr	3.00
LM2940T-5.0	Low Dropout Regulator	2.80
LM3524N	Switching Regulator	4.90
LM3578AN	Switching Regulator	6.65
LM7808CT	Fixed Pos Regulator	0.75
LM78L05ACZ	3 Term Pos Regulator	0.85
LM78L12ACH	3 Term Pos Regulator	2.40
LM78L12ACZ	3 Term Pos Regulator	0.60
LM78L15ACZ	3 Term Pos Regulator	0.55
LM78L24ACZ	Order as MC78L24CP	0.55
LM7905CK	Also LM320K-5.0	6.50
LM7905CT	3 Term Neg Regulator	1.80
LM7912CK	Also LM320K-12	6.50
LM7912CT	Also LM320T-12	1.25
LM7915CK	3 Term Neg Regulator	3.35
LM7915CT	3 Term Neg Regulator	1.15
LM79L05ACZ	Also LM320LZ-5.0	0.70
LM79L12ACZ	3 Term Pos Regulator	0.60
LM79L15ACZ	3 Term Pos Regulator	0.50
LMC7660IN:NAT	Switch Cap Volt Conv	5.05
LP2950CZ-5.0	Micropower Regr	2.90
LP2951CN	Micropower Adj Rgltr	3.70
LT1054CN-8	Voltage Converter	11.05
MC3423P	Crowbar Detector	1.30
MC34063AP1	DC - DC Converter Ctrl	2.30
MC34064P-5	Power On Reset, U/V	2.00
TL431CLP	Positive Shunt Regltr	1.70
TL494CN	Switching Regulator	1.25
TL496CP	Switching Regulator	2.90
TL497ACN	Switching Regulator	2.70
UC3842N	PWM Current Mode	6.20

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ADVERTISING INDEX

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LASER POINTERS

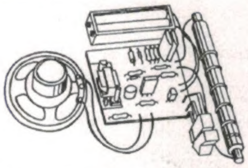
Two new 5mW at 660nm (very bright!) laser pointers. One type in a very small flat plastic case, the other in a small metal cylindrical case fitted with a keychain. Both powered by 3 LR44 batteries and APC driver circuitry. Greatly reduced prices: **$55 ea.**

UV MONEY DETECTOR

Portable UV source. Commercial product for checking paper money. Has two AA batteries and an inverter to step up the voltage to power a 50mm long, cold cathode UV tube. Simple circuit. Inverter can dimly light a 4W fluoro tube. Takes about 250mA. Case 82 x 46 x 21mm: **$5** ea or **5 for $19**

GEIGER COUNTER KIT

PRICE BREAKTHROUGH!



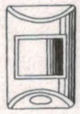
Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all onboard components, a Money Detector (see above), speaker and YES, the Geiger tube is included. **$30**

12V - 2.5W SOLAR PANEL KIT

US amorphous glass solar panels only need terminating and weather proofing. Includes clips and backing glass. Very easy to complete. Size: 305 x 228mm, Voc 18-20V, Isc 250mA. **$22 ea, 4 for $70**

Efficient switching regulator kit also available: suits 12-24V batteries, 0.1-16A panels, **$27**. Also available, simple shunt regulator kit **$5**

PIR MOVEMENT DETECTOR



Commercial quality 10-15M range PIR movement detectors. Second hand, tested and guaranteed, have relay contact outputs, a tamper switch and operate from 12V DC. Compatible with standard alarm systems. Includes circuit **$10** ea. or **4 for $32**

PLASMA EFFECTS SPECIAL

Ref: EA Jan '94. Produces a fascinating colourful high voltage discharge in a domestic light bulb, or light up an old fluoro tube or any gas filled bulb. The EHT circuit is powered from a 12V to 15V supply and draws a low 0.7A. Output is about 10kV AC peak. PCB and all on-board components (flyback transformer included), and instructions: **$28** (cat K16) Hint: connect the AC output to one of the pins of a non-functional but gassed laser tube, amazing results! The special? We supply a low power functional laser tube for an additional $14, but only if purchased with the plasma kit. Total price: **$42** (Includes instructions on getting the laser tube to produce a laser beam!)

FOG MACHINE

Mains operated fog machine: 700W, 3000 cubic meter per minute capacity, remote operation with lead supplied. Great for light shows and lasers! Low introductory price: **$300**

RARE EARTH MAGNETS

Very strong!!! Zinc coated. Cylindrical: 7 x 3mm, **$2** (G37) 10 x 3mm: **$4** (G38), toroidal 50mm outer, 35mm inner, 5mm thick: **$9.50** (G39)

MORE ITEMS & KITS

See our other full page advertisement elsewhere in EA.

And ask for our latest catalog to be sent with your next order.

LED FLASHER KIT

3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50** ea, **10 for $12**

SIMPLE MUSIC KIT

3V, 3-pin IC plays a single tune. Two ICs that play different tunes, speaker and small PCB: **$3** or **10 for $25**

MAGNIFIERS - LOUPES

Four types (see review S.C. May 96). Small jewellers eyepiece with plastic lens: **$3**. Others in the range have two glass lenses, used where the loupe is placed close to the object being magnified. Focal point just below base of the loupe. Loupe with 50mm dia viewing area, 10 x mag: **$8**, 75mm: **$12**, 110mm **$15**.

VISIBLE LASER DIODE KIT

We have redesigned our 5mW 660nm visible laser diode kit so the PCB fits neatly into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **less than $100**

2 CHANNEL UHF KIT BARGAIN

304MHz with 1/2 million codes. Compact transmitter with keychain case, PCB, 12V battery and all components. Receiver kit includes PCB, all components (with 2 decoder ICs and 2 relays with 2A contacts). Range up to 50m. One 2 button Tx kit and one 2 ch Rx kit. Bargain at **$30**

IR REMOTE CONTROL TESTER

Kit includes a blemished fibre optic coupled IR converter tube with either 25 or 40mm diameter window, and our night vision HT power supply kit. The tube responds to IR and visible light, and can 'see' the output of an IR remote control. **$30**

SOLID STATE PELTIER DEVICES

12V 4.4A, can be used to make a thermoelectric cooler - heater. Basic info included. **$25** 12V DC fan **$8**

IR REPEATER KIT

Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

VISIBLE LASER DIODE MODULE

Industrial quality 5mW/670nm laser diode module. Dimensions: 12mm dia x 43mm long. Includes visible laser diode, diode housing, APC driver circuit and collimation lens all factory assembled in one small module. Has superior collimating optic, divergence angle less than 1 milliradian: **$65**

STEPPER MOTOR PACK

Pack of seven stepper motors. Save 50%! Includes 3 x M17, 2 x M18, 2 x M35, all new: **$36**

ALCOHOL BREATH TESTER KIT

Has high quality Japanese thick-film alcohol sensor. Kit includes PCB, all components, meter movement: **$30**

WEB ADDRESS

See our latest catalog and list of items at our NEW web site at:

http://www.ozemail.com.au/~oatley

VIDEO TRANSMITTER

Low power UHF TV transmitter with adjustable level audio and video inputs, power switch and power in socket. Needs 10 to 14V DC at 10mA. Set to Ch 31, can be altered. Video input accepts standard composite video (eg CCD camera), comes in small metal box and built-in telescopic antenna. Range typically 7 to 10m for internal TV antenna: **$25**

STROBE KIT

Based on a flash unit from a disposable camera. We supply an additional PCB and components (plus instructions) to convert the flash unit into a low power consumption, highly visible strobe light (works off a 1.5V battery). Use it as a bicycle warning light, or as a strobe light (use several in a darkened room for best effect). **$6 ea or 5 for $25**

MINIATURE FM TRANSMITTER

Very small ready-made FM transmitter in a small black metal case. Powered by a 1.5V watch battery (included), has an in-built electret microphone. Tuning range: 88 to 108MHz (adjustable). Range approx 50m: **$32**

3-STAGE TUBE CLEARANCE

SC Nov. 95. 25mm 3-stage fibre optic night vision tube, works in starlight EHT supply kit and eyepiece. **$200**

ARGON-ION HEADS

Used Argon-Ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. We provide a circuit for a suitable power supply. Dimensions: 35x16x16cm, weight 6.0kg. 1 year guarantee on head. Needs a 1kW transformer, available elsewhere for about $170. Argon head only: **$300**

CCD CAMERA - TIME LAPSE VCR RECORDING SYSTEM

Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90**

MASTHEAD AMPLIFIER

High performance low-noise masthead amplifier covers VHF-FM-UHF and is based on a MAR-6 IC. Includes two PCBs, all on-board components and a balun former. REDUCED PRICE: **$15** for basic kit. Suitable plugpack **$10** Waterproof box for masthead amplifier: **$2.50**, plastic box for combiner: **$2.50**

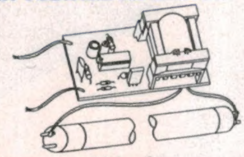
SECURE IR SWITCH

Toggles a relay from an IR transmitter. Coded transmitter and receiver so a number can be used in the same area. Includes commercial one button transmitter, receiver PCB and parts to operate a relay (not supplied): **$22**

COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT

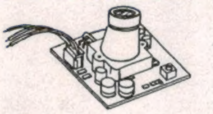
Kit will drive two 4, 5, 6 or 8-wire stepper motors from an IBM computer parallel port. Motors require a separate power supply (not included). Includes detailed manual and software (on 3.5" disk). NEW SOFTWARE will drive up to 4 motors (needs two kits), with linear interpolation across four axes. PCB 153 x 45mm, all on-board components, manual, software and two M18 stepper motors: **$44** This kit with the stepper motor pack: **$65** Kit, no motors: **$32**

HIGH VOLTAGE AC DRIVER



Produces a high frequency, high voltage AC for ionising most gas-filled tubes up to 1.2m long. It can partially light a standard 36W fluoro tube with two connections, taking less than 200mA from a 12V battery. Heat the tube filaments to get about 6W of light output. Includes PCB, small fluoro tube and components. **$18**

CCD CAMERA BONUS SPECIAL



Tiny (38 x 38 x 27mm) PCB CCD camera, 0.I lux, IR responsive (works in total dark with IR illumination). Connects to any standard video input or via a modulator to aerial input. SPECIAL pack 1: standard or pinhole camera with bonus VHF modulator OR regulated 10.4V plugpack. REDUCED PRICE **$140**

SPECIAL pack 2: pack 1 PLUS video transmitter: **$155**

LOW COST IR ILLUMINATOR KIT

Allows a CCD camera or a night viewer to see in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs: REDUCED PRICE **$30**

OATLEY ELECTRONICS

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